SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MAY, 1929.

GENERAL PHYSICS.

1389. Determination of Gas Density with the Displacement Balance. Part III. Electromagnetic Balance for Laboratory Use. A. Stock. *Zeits. f. phys. Chem.* 139. *pp.* 47–52, *Dec.*, 1928.

A description is given of a balance constructed on the basis of the theoretical considerations and preliminary experiments already reported [see Abstracts 1488 (1926); 522 and 2192 (1927)], the measurements being made electromagnetically. The balance is suitable for scientific and industrial laboratories. Good results are obtained with the fractions derived from a mixture of unsaturated hydrocarbons in a high vacuum at condensation temperatures ranging from − 190° to − 40°, and with several mixtures of carbon dioxide and air. T. H. P.

1390. Mechanical and Optical Lengths of a Steel End-Gauge. F. H. Rolt and H. Barrell. *Roy. Soc., Proc.* 122. *pp.* 122–133, *Jan.* 1, 1929.

It is pointed out that as the ends of such a gauge have sufficient polish to observe interference rings the optical length can be found by placing the gauge between the mirrors of a Fabry-Perot étalon. The factors which make this length different from the geometrical and mechanically measured lengths are discussed, and a method of arriving at the differences by wringing a number of such gauges together is worked out. The experimental realisation of this is described, and results for two neon radiations are given. For visible radiations longer than $0 \cdot 55\mu$ in wave-length the difference (M − O) of the mechanical and optical lengths is found to be $0 \cdot 27\lambda + 0 \cdot 005\mu$, where λ is expressed in microns. The method of calculation of excess fractions by a method of least squares is appended. F. S.

1391. Division of a Circumference. P. Vocca. *Accad. Sci. Torino, Atti,* 63. 11*a*–14*a*. *pp.* 265–271, 1927–1928.

Description of an apparatus for automatically dividing a circumference into any given number of equal parts. A. D.

1392. Influence of Tremors on Chronometer Rates. G. P. Arcay. *Comptes Rendus,* 187. *pp.* 1125–1128, *Dec.* 10, 1928.

A pocket chronometer carefully rated when "carried" suffers retardation, after some days, of 3, 4 or 5 seconds, and this has been attributed to oil, or to the instability of the alloys which form the spring or balance. Tissot, however, working in the Chronometrical Laboratory at Besançon, has traced it to the effect on the watch of small tremors. It has not been possible to sort out the effect of ship rolling, but he gives the results of nine experiments, amongst which the most important are: that the effect is greatest when the watch is held in the horizontal position; is always a retardation which becomes permanent; is a diminution of the amplitude of the balance oscillation, and this diminution is not so marked where the watch is a well-finished one; cannot be attributed to any defect of isochronism. The author concludes that the retardation is due to the jamming of the pivots in the jewelled holes, a jamming conduced by want of polish in jewel and pivot. The testing by tremors thus becomes a criterion of quality of workmanship. A. S. D. M.

1393. Absorption Tube for Variable Liquid Thickness. C. Leiss. *Zeits. f. Physik*, 52. 9–10. *pp.* 748–749, 1928.

Briefly describes the construction of a new absorption tube in which the distance between the two windows is continuously variable up to 20 mm. The variation is produced by means of a screw thread, and the distance apart is measurable to 1/20 mm. The liquid only comes into contact with glass, the sliding tube being of that material, and leakage is reduced by making it a good fit in the fixed tube. This contact with glass only has the further advantage of eliminating contamination. R. C. F.

1394. Pendulum with Very Small Damping. R. Planiol. *Comptes Rendus*, 187. *pp.* 933–935, *Nov.* 19, 1928.

The paper deals with experimental observations of the damping of the vibrations of a torsion pendulum (a brass cylinder 70 mm. in dia. and 80 mm. long suspended by a quartz fibre 0·25 mm. in dia. and 45 mm. long) in an evacuated enclosure. The cylinder carries a mirror to indicate the amplitude of the swing. The period of double oscillation was 10·942 sec. The vacuum pressure, obtained by means of a Holweck molecular pump, was measured by means of a Knudsen absolute manometer, which indicated 0·8 bar. at night and 0·05 bar. in the daytime. It is shown that the damping of the pendulum due to the gas is entirely negligible, the only damping being that due to the quartz suspension. The amplitude decreased from 12·6 to 7·1, to 3·8 and to 2·3 in 5, 10 and 15 days respectively. A. B. W.

1395. Interferometer U-Gauge with Closed Auxiliary Reservoirs. C. Barus. *Nat. Acad. Sci., Proc.* 14. *pp.* 855–857, *Nov.*, 1928.

Describes experiments with both reservoirs of the U-gauge closed, each being connected to one of two identical Dewar flasks of large volume, containing two sensitive thermometers reading at least to 0·01° C. Gives the relation between the readings of the micrometer of the interferometer, which indicate the pressure on one side of the gauge and the relative change in the temperature of the two Dewar flasks, $\Delta\tau = d\tau' - d\tau$, when τ and τ' are the original temperatures of the flasks; $\tau' - \tau$ was always positive, $d\tau' - d\tau$ also as a rule. Curves have been plotted showing the relations between the values given by the thermometers and by the U-gauge over a period of about eight hours. The reasons for the differences, which in some cases are due to a lag in the readings of the thermometers, are discussed. H. N. A.

1396. Mercury and Oil Manometer. R. Darbord. *Comptes Rendus*, 188. *pp.* 50–52, *Jan.* 2, 1929.

For measuring pressures of the order of a few mm. or cm. of mercury a mercury manometer is not sensitive enough, while oil has the disadvantage of not running off the glass and of sometimes disengaging bubbles of gas into the vacuum. By using mercury in the U-tube, and oil above it on one side, these disadvantages are removed, but the sensitivity is conserved. W. G. B.

1397. Automatic Mercury Still. F. L. Robeson. *J.O.S.A. and R.S.I.* 18. *pp.* 72–74, *Jan.*, 1929.

A new form of vacuum mercury still is described. This still is easily made from standard laboratory glassware, starts and stops automatically, and needs very little attention. The power required is 90 watts for an output of 100 gm. of mercury per hour. AUTHOR.

1398. Logarithmic Law of Mixtures. J. Dejmek. *Phys. Zeits.* 29. *pp.* 907–908, *Dec.* 1, 1928. *Paper read before the Deut. Naturforscher u. Ärtze, Hamburg, Sept.*, 1928.

A suggestion as to the possible application of the law to binary alloys without mixed crystal structure. A note by the editor at the end refers to the work of G. Szivessy and M. Richartz on binary liquid mixtures of a similar character. S. G. B.

1399. Friction Constant and Wall-Surface Film. J. Tausz and F. v. Körösy. *Zeits. f. phys. Chem.* 140. *Abt. A.* 3–4. *pp.* 263–272, *Feb.*, 1929.

The Traube-Whang effect [see Abstract 662 (1929)] is not due to a change in viscosity, but to a change in surface tension, and the observations can be explained by the experimental method used. Traube draws his liquid by suction into the capillary; when the wall is coated with paraffin there is no wetting, and the meniscus cannot go up the paraffin film. The decisive factors for the velocity of discharge are not the friction on the wall, but the surface tension balancing the hydrostatic pressure and the consequent capillary rise. The velocity of efflux is not shortened by a thin coating of polar (as distinct from nonpolar) substances. An equation is deduced for the movement of the meniscus. Viscosity determinations by the Traube apparatus are unreliable, and modifications of the rules of Stokes and Poiseuille and corrections for the permeability of collodion filters (which is explained by Brinkmann and Szent-Györgyi) are not required. H. B.

1400. Viscosity and Flow Orientation. S. Kyropulos. *Phys. Zeits.* 29. *pp.* 942–947, *Dec.* 15, 1928.

The shapes of the viscosity-temperature curves, determined by the torsion pendulum method, of certain saturated hydrocarbon oils are shown to fit in with the assumption of an orientation of the molecules of the fluid by the oscillating cylinder, and a preferential direction of minimum friction for the different hydrocarbon molecules, the friction along this direction being independent of the length of the hydrocarbon chain. Light is thrown on the discrepancy between the results given by the viscometer and the oil-testing machine, and the general importance of " flow orientation " in lubrication and other such processes is indicated. W. S. S.

1401. Surface Tension of Solutions. Part I. Influence of Salts on the Surface Tension of Aqueous Solutions of Urethane. Measurements. Part II. Calculation of Surface Tension from the Weights of the Drops. Part III. Discussion of Results. S. Palitzsch. *Zeits. f. phys. Chem. Abt. A.* 6. *pp.* 379–431, *Dec.*, 1928.

Reviewing the literature the author finds that only Goard and Rideal

(*J. Chem. Soc.* 125, pp. 1668–1676, 1925) have made their measurements of the surface tension of aqueous phenol solutions in the presence of salt on lines like himself; but he questions their phenol concentrations, which should have been corrected after the addition of the salts to the solution. The method of drop counting is unobjectionable when the drop weights are determined. The experiments concern solutions in water of urethane to which 25 different inorganic salts and HCl are added in various concentrations, all at 25°. The observed surface tensions s.t. were found to keep constant for longer periods than is assumed. Although Tate showed in 1864 that the s.t. is proportional to the weight of the drop, and not to its volume, mere counting is still relied upon frequently. Improved formulæ have been given by Morgan [see Abstract 1373 (1915)] and by Harkins; Iredale's method of calculation [see Abstract 2042 (1923)] is really the same as that of Harkins. When different amounts of a salt are added to the same urethane solution the s.t. may be raised or lowered. When, however, the salt concentration is kept constant, while the urethane concentration is varied, different salts give very similar curves resembling those of the salt itself; the curves cut the s.t. curve of the urethane u solution, and the intersections shift with increasing salt concentration towards diminishing u percentages. The maximum decrease of the s.t. of u is characteristic for a salt; but the u concentration at which this maximum effect is observed does not in the case of NaCl (especially studied) depend upon the amount of salt present, and is 10 gm. of urethane per 100 gm. of water. At higher u concentration the curves approach one another again, but the decrease in s.t. produced by a certain amount of salt is never zero. Salts of divalent acids (sulphates, chromates, secondary phosphates) have twice the effect as salts of monovalent acids (including primary phosphates). All the phosphates are strongly active; potassium ferrocyanide is most active; different preparations of KCl gave discordant results although apparently pure. The curves representing the effect of increasing additions of pure salts on urethane solutions are never quite rectilinear, though nearly so, and the sense of curvature may change. Hydrochloric acid has a lower s.t. than water, and the effects of its salts are small. H. B.

1402. Surface Tension and Surface Orientation in Homologous Series. K. W. Hunten and O. Maass. *Am. Chem. Soc., J.* 51. *pp.* 153–165, *Jan.*, 1929.

The temperature coefficients of surface energy are sometimes higher than the Ramsay-Shields constants. The abnormally high values have with partial success been ascribed to high molecular weight, and the low values to dissociation. The authors tried whether vertical orientation of the molecules, which would bring more than the assumed number of molecules into surface action, might explain the discrepancies. They determine the viscosity (by capillary rise) and density of fatty acids, and of the long chain paraffin dicetyl for a large temperature range (− 20° to 150° in some cases), and find that the angles of contact with glass are zero. The total surface energies of the acids increase rapidly to a series constant, the paraffins more slowly to a similar constant. The total surface energy values and the high Ramsay-Shields constants cannot be explained by complete orientation in the vertical direction; but some orientation would account for the regularity in the former and the high values in the latter. H. B.

1403. Surface Tension of Liquid Sulphur Dioxide. V. M. Stowe. *Am. Chem. Soc., J.* 51. *pp.* 410–415, *Feb.,* 1929.

The surface tension was determined by the capillary tube method at temperatures ranging from − 79° C. to + 50° C., the measurements from − 20° to − 79° C. in the undercooled region are less accurate than the others; de Block's equation $\gamma = 0 \cdot 061534\ (157 \cdot 5 - t)^{1 \cdot 2}$ fits the experimental results excellently over a range of 70°. The functions E_σ, the total energy of surface formation, and V the molal volume were evaluated; the value of the second places SO_2 between chloroform and benzene in Hildebrand's solubility table. The value found for the constant k in the equation of Ramsay and Shields was 2·134, nonpolar liquids average about 2·12. H. N. A.

1404. Exact Solutions of Hydrodynamic Differential Equations. C. W. Oseen. *Arkiv f. Mat., Astron. och Fysik, Stockholm,* 20. 22. *pp.* 1–9, 1928. *In German.*

This mathematical paper continues previous investigations on two-dimensional stationary fluid motion [see Abstract 244 (1928)] for which the Stokes' steam function has the form:

$$C\chi + f(\phi),\ \ \phi = -2(a \log r + b\vartheta)/(a^2 + b^2),\ X = 2(b \log r - a)/(a^2 + b^2).$$

Return is made to the case $Cs' = 2a$, when for three examples the shapes of the stream lines have been determined from which their general form is now discussed. A preliminary investigation is also made of a class of three-dimensional fluid motions, the determination of which depends on the solution of the usual differential equations. H. H. Ho.

1405. Fluid Motion in a Curved Channel. W. R. Dean. *Roy. Soc., Proc.* 121. *pp.* 402–420, *Nov.* 1, 1928.

The author investigates theoretically the stability of flow under pressure through a curved channel (*i.e.*, between concentric cylinders). It is shown that the motion can become unstable for small disturbances of a certain type, which could not persist in a straight channel. This curvature effect is applied by analogy to explain the known absence of a marked critical velocity of flow in a curved pipe. W. S. S.

1406. Resistance to a Disc Rotating in a Viscous Fluid. C. Schmieden. *Zeits. f. Angew. Math. u. Mechanik,* 8. *pp.* 460–479, Dec., 1928.

Mathematical. The rotation of a disc in a cylinder of greater radius and of finite length is considered, and numerical results and graphs for various values of the parameters are given. W. G. B.

1407. Solution of Oseen's Equation for the Slow Motion of a Body in a Viscous Fluid in Terms of Spherical Harmonics. H. Dahl. *Arkiv f. Mat., Astron. och. Fysik, Stockholm,* 21. 5. *pp.* 1–22, 1928. *In German.*

Mathematical. The functions of the radius that occur are expressed as integrals involving Legendre functions. The final formula for the resistance can be very simply expressed. W. G. B.

1408. Theory of Ship Wave Resistance. E. Hogner. *Arkiv f. Mat. Astron. och Fysik, Stockholm,* 21. 7. *pp.* 1–11, 1928. *In English.*

The author shows that his form of the wave equation leads to a simple final result for the wave resistance for any pressure distribution.

W. G. B.

1409. Pressure Distribution on a Body in Plane Potential-Streaming. W. Prager. *Phys. Zeits.* 29. *pp.* 865–869, *Dec.* 1, 1928.

The effect of a body in modifying a stream may be simulated either by a system of sources and sinks or by a vortex sheet at its surface. Knowledge of the latter enables the surface velocity to be calculated, and from that, the pressure. The strength of the vortex sheet can be found from an integral equation, and this can be replaced (approximately) by a system of linear equations which can be solved numerically. The case of an ellipse is given by way of illustration. W. G. B.

1410. Vortices behind an Obstacle. H. Bénard. *Comptes Rendus*, 187. *pp.* 1028–1030, *Dec.* 3, 1928.

Compares the results for obstacles of " knife-blade " shape with those of Camichel, Dupin and Teissié-Solier for a cylinder, using corrected values of the viscosity. Departure from the law of similitude remains, and its cause is still to be sought. W. G. B.

1411. Alternate Vortices and the Law of Similitude. H. Bénard. *Comptes Rendus*, 187. *pp.* 1123–1125, *Dec.* 10, 1928.

As reasons why the author's measurements upon the vortices only roughly obey the laws of similitude, the influence of surface tension is suggested, but this when examined produces no marked improvement. Nor does the influence of the finite length of the obstacle. It is finally suggested that the inevitable fluctuations in the successive periods, which are unavoidable in the author's method, dealing with only small numbers of vortices, may be the cause. The acoustical methods of other observers automatically average these out. [See preceding Abstract.] W. G. B.

1412. Formula Generalising Cauchy's Integral and its Hydrodynamical Interpretation. D. Pompeiu. *Comptes Rendus*, 187. *pp.* 1121–1123, *Dec.* 10, 1928.

Translated into hydrodynamics, the formula yields d'Alembert's principle in the form in which he enunciated it. W. G. B.

1413. Slow Non-Permanent Motion of a Cylinder in a Viscous Incompressible Fluid. A. Gay. *Comptes Rendus*, 188. *pp.* 143–145, *Jan.* 7, 1929.

The equations of motion form a linear system of integral equations, which, it is suggested, may be solved by successive approximation. W. G. B.

1414. Cleavage of Stretched Caoutchouc and Disturbance of its Cleavage and Fracture Planes by Additions. M. le Blanc and M. Kröger. *Zeits. f. Elektrochem.* 34. *pp.* 725–734, *Nov.*, 1928.

It is shown that the conception of cleavage can be applied to stretched caoutchouc as also the contingent idea of disturbance of cleavage planes. The fracture surfaces of several samples have been investigated, the adsorption process consequent on additions to the caoutchouc discussed, and a systematic study of state derived to account for elastic behaviour at different temperatures. Finally, the hitherto unknown dependence of fracture value on cross-section has been experimentally studied for different shapes. [See Abstract 2574 (1928)]. H. H. Ho.

1415. Symmetrical Deformations of an Elastic Slab. R. Serini. *Accad. Lincei, Atti*, 8. *pp.* 569–572, *Dec.* 2, 1928.

A general solution of the problem. A. D.

1416. Extension of St. Venant's Theory to Thin Elastic Rods of any Shape. J. Haag. *Comptes Rendus*, 187. *pp.* 1031–1032, *Dec.* 3, 1928. W. G. B.

1417. Elastic Equilibrium of a Rectangular Prism. Belzecki. *Comptes Rendus*, 187. *pp.* 1119–1121, *Dec.* 10, 1928.

Mathematical. Generalises the former results [see Abstract 2565 (1928)]. W. G. B.

1418. Partial Differential Equation of the Second Order Occurring in the Theory of Plastic Bodies. C. W. Oseen. *Arkiv f. Mat. Astron. och Fysik, Stockholm*, 20. 24. *pp.* 1–21, 1928. *In German.*

The theory of plasticity established by St. Venant is based (1) on sliding occurring when the maximum stress acquires a certain value and retains this value during sliding, and (2) for the two-dimensional case on the direction of maximum stress agreeing with that for the maximum frictional resistance against sliding. The author shows how the equations developed on this theory can be transformed in the simplest way by a Bäcklund transformation in which the deviations of the second order occur only linearly. The paper is wholly mathematical. R. S. R.

1419. Oscillations under a Quadratic Law of Resistance. T. Pöschl. *Phys. Zeits.* 29. *pp.* 938–942, *Dec.* 15, 1928.

The differential equation of the motion considered runs $\frac{dv^2}{dx} \mp 2kv^2 + 4a^2x = 0$, the determination of the ambiguous sign being such as to make $2kv^2$ a resistance to the motion. An approximate solution is developed which is suitable for numerical calculations of the successive amplitudes and periods of the oscillation. The period of successive swings is shown to decrease and to tend in the limit to that for zero damping ($k = o$). W. S. S.

1420. Temperature Change of Young's Modulus of Fused Quartz. H. D. H. Drane. *Roy. Soc., Proc.* 122. *pp.* 274–282, *Jan.* 1, 1929.

By an experimental study of the behaviour of a cantilever of fused quartz at temperatures ranging from − 183° C. to 700° C. anomalies in the mechanical behaviour, possibly closely related to the optical anomalies found by Rayleigh [Abstract 1056 (1921)], are established. The work is of importance to users of quartz fibre suspensions in apparatus subject to temperature changes. W. H. Ge.

1421. Catenary Problems in Mechanics. J. W. Campbell. *Roy. Soc. Canada, Trans.* 22. *Sect.* 3. *pp.* 353–357, *May*, 1928.

The fact that a uniform, flexible, inextensible chain when supported at its extremities will hang under the influence of its own weight in a hyperbolic cosine curve has long been known. When the sag is not too great the curve approximates to a parabola, and in concrete problems it is common practice to use the parabolic approximation of the catenary. The purpose of this paper is to indicate how these problems can be solved conveniently by a suitable arrangement of the equations and the use of hyperbolic functions. AUTHOR.

1422. Classification of Orbits. L. A. Pars. *Cambridge Phil. Soc., Proc.* 25. *pp.* 1–19, *Jan.*, 1929.

The present paper is concerned with a simple type of dynamical system having only two freedoms and of "separable" type. The essential simplification introduced by this restriction is that the motions in the two coordinates can be discussed to some extent independently of each other. In Part I, a method of classification of the possible orbits is explained; four constants are needed to define the motion completely, but the general nature of the orbit depends on two constants suitably chosen, and the classification is effected by reference to a plane in which the two constants are taken as Cartesian coordinates. It is shown that the plane of reference is divided into regions by critical curves, and that the orbits, represented by points in the same region, are of the same general type. The various possible types of orbits, and their stability, in a special sense, are discussed. In Part II the theory is applied to the orbits for a particle under a central attraction proportional to the inverse $(n + 1)$th power of the distance. The possible types of orbits are found to be essentially the same for all values of $n > 2$. In Part III the theory is applied to a particle subject to an attraction of Newtonian type to two fixed centres. H. H. Ho.

1423. Molecular Theory of Crystals. K. Weissenberg. *Zeits. f. phys. Chem.* 139. *pp.* 529–583, *Dec.*, 1928.

A fuller and more rigorous account of Weissenberg's molecular theory of crystals. The foundations of the conception of the molecule in vapour, solution and crystal is treated. It is shown that the Schönflies-Federof symmetry rule governs not only the morphological and physical properties of the crystal, but also its chemical constitution. A "guiding lattice hypothesis" (*Leitgitterhypothese*) is put forward, which is the equivalent for crystals, of Avogadro's hypothesis for ideal gases and solutions. The "crystal molecule" is regarded as the largest particular group whose symmetry elements do not include translations. The number of such groups (*Leitzähligkeiten*) possible in a given space-group is geometrically fixed by the known symmetry elements of the space-group. A table is given for elements, inorganic and organic compounds of determined space-group showing that with 58 exceptions the "crystal-molecule" is identical with the ordinary chemical molecule. Polymerisation is believed to account for 44 exceptions, and may account for the 14 others in which the crystal-molecule is a small integral multiple of the ordinary chemical molecule. W. H. Ge.

1424. Optical Properties of Heulandite. P. Gaubert. *Comptes Rendus*, 187. *pp.* 1057–1059, *Dec.* 3, 1928.

An experimental study of the influence of heat and of loss of water of crystallisation on the optical properties of Heulandite. The crystals could be heated to 109° C. in some organic liquids without loss of any of the water contained at 20° C. so that the effect of the two factors could be separated. It is shown that at temperatures up to 109° C. the optical properties depend largely on the amount of water of crystallisation in the crystals. W. H. Ge.

1425. Crystal Structure and Ferromagnetism. O. v. Auwers. *Phys. Zeits.* 29. *pp.* 921–927, *Dec.* 15, 1928.

A critical review of the work of 29 papers showing that present results are in agreement with the Heisenberg quantum-mechanics theory of ferromagnetism. W. H. Ge.

1426. Mechanical Twinning, Plasticity and Strengthening of Metals (Zinc and Cadmium). E. Schmid. *Zeits. f. Metallkunde*, 20. *pp.* 421–425, *Dec.*, 1928.

Although the twinning is limited [see Abstract 1807 (1928)], its indirect influence on plasticity must not be overlooked, because the twinning brings new planes into positions favourable for further slipping. The strengthening depends upon the shear strength of the slip systems. The shear strength may, according to Haase and Boas, be increased to twice its value, whilst the elongation due to the twinning will only represent a few per cent. of the total elongation which may be very considerable. When mechanical twinning takes place in a sphere, the shape changes into an ellipsoid, but two cross-sections (one of which is the slip plane) remain circular, and these two and their inclination are characteristic for the phenomenon. H. B.

1427. Recrystallisation of Metals. R. Karnop and G. Sachs. *Zeits. f. Physik*, 52. 5–6. *pp.* 301–313, 1928.

An experimental study by etching of the influence of intermediate heating on the commencement of recrystallisation of aluminium and on the size of the individual crystals during stretching. W. H. Ge.

1428. Strength of "Improved" Crystals of an Aluminium Alloy. G. Sachs. *Zeits. f. Metallkunde*, 20. *pp.* 428–430, *Dec.*, 1928.

The alloy which is capable of "improvement" by suitable heat treatment is the same as that described by the author in collaboration with Karnop [see Abstract 2904 (1928)] and contains 5 % of Cu. In the present paper the author discusses the reasons for the difference in properties of the improved and the unimproved "glowed" crystals; further experiments are in progress to elucidate this, but all the results so far obtained point to the fact that the improved crystals are genuine mono-crystals, and that the improvement is not due to any separating out of the components, but that the reason for it must lie deeper. H. N. A.

1429. Growth of Zinc Crystals by the Czochralski-Gomperz Method. A. G. Hoyem and E. P. T. Tyndall. *Phys. Rev.* 33. *pp.* 81–89, *Jan.*, 1929.

The conditions necessary to grow zinc crystals of 2·7 mm. in dia. and of any desired orientation are determined experimentally. When a constant rate of growth is used and the crystal is initially given the desired orientation by starting it on a suitable nucleus the determining factor for the successful growth of a single crystal rod 10 cm. or more in length is found to be the temperature gradient existing in the column of liquid zinc just below the growing crystal. The appropriate temperature gradient is a function of the orientation of the crystal. It is depicted graphically in a figure which shows the upper and lower limiting curves for the region of successful growth when the rate of growth is 1·2 cm/min. The lower curve rises from orientation 0° to 45° and falls from 45° to 90° The upper curve lies slightly above and parallel to the lower curve from 0° to 50°, but then rises very sharply. The shape of this region does not seem such as to be attributed only to variation in heat conductivity with orientation. Attempts to grow crystals outside of the appropriate region result in sudden or gradual changes to new orientations. In the latter the orientation shifts gradually through a considerable range. Illustrations are given of such changes. Authors.

1430. Crystal Structure of Anhydrous Silicotungstic Acid and Related Compounds, and their probable Molecular Formulæ. A. G. Scroggie and G. L. Clark. *Nat. Acad. Sci., Proc.* 15. *pp.* 1–8, *Jan.*, 1929.

By stepwise addition of alkali to the acid, the amount of alkali necessary to cause the initial decomposition of the acid has been determined, and a series of modified acids with 7, 8 and 10 tungsten atoms has been isolated. X-ray examination of the acid shows that it crystallises as a body-centred cube, with a side-length of 12·16 Å.U. This dimension applies to the acids with 8, 10, and 12 tungsten atoms, and to the modifications of the latter that contain 2 mols. of water ($2H_2O . SiO_2 . 12WO_3$) or 8 mols. of water [$2H_2O . (6H_2O . SiO_2 . 12WO_3)$], but not to the anhydride ($SiO_2 . 12WO_3$). Phosphodecimolybolic acid similarly forms a body-centred cube with a side length of 14·31 Å.U. A modified formula for the acid—$2H_2O(6H_2O . SiO_2 . 12WO_3)$ or $H_4[(SiO_4)(W_{12}O_{30})(OH)_{12}]$—and a new spatial structure have been deduced to correlate adequately the X-ray and chemical data. H. H. Ho.

1431. Form and Potential Energy of the Isomorphous Crystals, Ruby and Hæmatite. J. Topping. *Roy. Soc., Proc.* 122. *pp.* 251–273, *Jan.* 1, 1929.

A theoretical paper in which it is shown that the observed crystallographic data of Ruby (Al_2O_3) and Hæmatite (Fe_2O_3) are consistent with a model in which account is taken of both the electrostatic and a certain intrinsic repulsive force. It is further indicated that theoretically an *exact* hexagonal close-packet arrangement of the O ions is incompatible with the observed values of the interatomic distance and rhombohedral angle. Estimates of the values of the force-constants in the assumed law of intrinsic repulsive force between A^{+++} and O^{--} ions and for Fe^{+++} and O^{--} ions are found, and a value $\mu_{22} = 11$ for O^{--} ions is obtained. This value is in better agreement with the experimental data for crystalline *sodium nitrate*. W. H. Ge.

1432. Deformation of Fibres. R. O. Herzog and W. Jancke. *Zeits. f. Physik*, 52. 11–12. *pp.* 755–758, 1929.

Investigations with X-rays show that fibres of cellulose and natural silk can be worked, by compression and rolling, into a structure of the ainstropic class IV. F. J. W.

1433. Allotropic Modifications of Phosphorus. A. Smits. *Comptes Rendus*, 187. *pp.* 980–982, *Nov.* 26, 1928.

Phosphorus contains at least three kinds of molecules, α_1, α_2, β. In white phosphorus the two α modifications predominate and quickly change into one another at ordinary temperature, while the β is only formed at higher temperatures. Thus, white phosphorus behaves as if it consisted only of one pseudo-constituent α. The system is studied by distillation at low temperatures starting from a coloured phosphorus (not white). Nicolaiev (*ibid.* 186, p. 1621) had independently come to similar conclusions. H. B.

1434. Symmetry of Naphthalene. Kathleen Lonsdale (née Yardley). *Leeds Philosoph. and Lit. Soc., Proc.* 1. *pp.* 346–348, 1928.

The author has previously shown that to explain the lack of symmetry of many simple carbon compounds an anisotropic carbon atom must be assumed, and has suggested an atom with two A and two B valency

electrons; the linking of two carbon atoms is explained by the mutual sharing of an A and a B electron. It is shown that such atoms can be built up into a naphthalene molecule which has a centre of symmetry only, in agreement with X-ray investigations. This molecule also accounts for the differences in the absorption spectra of the ten dichlornaphthalenes.
H. N. A.

1435. Polarisation and Association. J. W. Williams. *Nat. Acad. Sci., Proc.* 14. *pp.* 932–936, *Dec.*, 1928.

Sidgwick [see Abstract 409 (1929)] ascribes association to formation of coordinative linkage, which is possible only when the molecule (*e.g.*, of water or alcohol) contains both a donor (oxygen) and an acceptor (hydrogen). Nitrobenzene is not associated because it contains no acceptor. But, if Beckmann's original data be relied upon, the molecular weight of nitrobenzene in benzene solution increases with the solute concentration, and nitrobenzene could therefore, even from the chemical standpoint, not be a non-associated liquid. Debye [see Abstract 410 (1929)] connects association with the mutual interaction of the dipoles of the liquid; but the molar polarisation of the solute is not always proportional to the mole fraction in the solution. Rolinski [see Abstract 600 (1929)] therefore calculates association by the aid of Debye's modification of the Clausius-Mosotti law, and concludes that the association should be the larger, the greater the dipole moment. This the author questions by referring to acetone, ethyl acetate, chloroform, etc., and further to phenol and benzoic acid in benzene solutions in which the molar polarisation is constant though the dipole moment varies largely with concentration. If the dipole moment were the only criterion, nitrobenzene should be associated to a higher degree than acetone; there must be another factor.
H. B.

1436. Molecular Association. Relations between the Viscosity of Binary Mixtures of Liquids and the Polarity of the Molecules. J. Errera. *Comptes Rendus*, 187. *pp.* 1278–1280, *Dec.* 26, 1928.

A continuation of a previous paper [see Abstract 710 (1929)]. The author concludes that when the molecules of the two compounds are nonpolar, or when one is dipolar and the other nonpolar, the curve of viscosity if not a straight line is always concave; when the curve is convex the two components are always dipolar. The viscosity curves for gases dissolved in a liquid confirm these two rules. The apparent exceptions to the first rule can be explained by the fact that new molecules are formed (chemical compounds) or by phenomena of demixtion when the liquids are partially miscible. The reasons for these relations are discussed.
H. N. A.

1437. Molecular Association. Part II. J. Errera. *Zeits. f. phys. Chem.* 140. *Abt. A.* 3–4. *pp.* 273–280, *Feb.*, 1929.

The viscosity curves of binary liquid mixtures have been studied from the standpoint of the polarity of their components, and the following relationships found: (1) In the case where the molecules of both components are not polar or one of the components is dipolar and the other not polar, the viscosity-concentration curve is concave. (2) When the curve is convex both components are dipolar. Apparent exceptions are explained. The viscosity curve in solutions of dissolved gases confirm these results. [For Part I see Abstract 1248 (1929).]
H. H. Ho.

1438. Magnetic Moment of the Lithium Atom. J. B. Taylor. *Zeits. f. Physik*, 52. 11–12. *pp*. 846–852, 1929.

Previous work on the magnetic moments of the alkali metals, sodium and potassium [see Abstracts 483 and 1994 (1927)], is now extended to lithium, the molecular ray method (*loc. cit.*) being again employed. A discussion of the experimental results shows that a nuclear moment must be present smaller than a third of the Bohr magneton. H. H. Ho.

1439. Metastability of Elements and Compounds as a Consequence of Enantiotropy or Monotropy. E. Cohen and H. L. Bredée. *Zeits. f. phys. Chem*. 140. *Abt. A*. 3–4. *pp*. 199–222, *Feb.*, 1929.

It has been established that the differential gas dilatometer devised by C. J. Smith [see Abstract 3152 (1927)] gives exact determinations of volume changes, and is eminently suitable for the study of polymorphic transformations. [See also Abstract 1052 (1929).] H. H. Ho.

1440. Relations between Doublets of Stripped Atoms in Five Periods of the Periodic Table. R. C. Gibbs and H. E. White. *Phys. Rev*. 33. *pp*. 157–162, *Feb.*, 1929.

Principal and diffuse doublets of stripped atoms in five periods of the periodic table from LiI to OVI, NaI to ClVII, KI to MnVII, RbI to ZrIV, and CsI to PrV:—Combining the data now available for the one-electron systems of the second, third, fourth, fifth and sixth periods, certain regularities are found to exist between the successive elements in each period and between corresponding elements in successive periods. These regularities are found by the application of the regular and irregular doublet laws. For the long periods which involve more penetrating orbits extrapolations of Z_i and s_i (Landé's formula) prove to be better guides in identifying doublets of the higher members of a sequence, although extrapolation of s (Sommerfeld's formula) is entirely satisfactory for the sequences in the short periods. Using the former we have been led to correct our previous identifications of the principal doublet of CeIV. The tighter binding of the d electron over both the s and p electrons starting with ScIII, YtIII and LaIII in the three long periods is especially well brought out by the Moseley type of diagram. Evidence is presented to indicate that the unexcited state of CeIV involves a $5d$ rather than a $4f$ electron. New data are given for VV, CrVI and LaIII. AUTHORS.

1441. Existence of Metastable Molecules in Active Nitrogen. J. Kaplan. *Phys. Rev*. 33. *pp*. 189–194, *Feb.*, 1929.

It has been shown in the present experiments that active nitrogen contains, among other things, metastable molecules of nitrogen possessing about 8 volts energy. The evidence that is presented to prove this statement is the excitation of the fourth positive group of nitrogen simultaneously with the quenching of the afterglow by a mild electric discharge. The main spectroscopic characteristics of a condensed discharge have been reproduced by simply introducing active nitrogen into a weak discharge. The relation of these phenomena to the structure of the nitrogen molecule is discussed. AUTHOR.

1442. Form of the Central Carbon Atom in Pentaerythritol Tetraacetate as shown by X-Ray Crystal Analysis. I. Ellie Knaggs. *Roy. Soc., Proc*. 122. *pp*. 69–76, *Jan*. 1, 1929.

The axes of the unit cell were found to be $a = 11{\cdot}98$ Å, $c = 5{\cdot}47$ Å; two molecules per unit cell; the crystals are built on a simple tetragonal lattice Γ_t, space group C_{4h}^4, each molecule has four-fold symmetry; the $-CH_2OCOCH_3$ radicals attached to the central carbon must be regarded as four asymmetric units, and the symmetry of the central carbon must approximate to that required by the space group, *i.e.*, there is a four-fold alternating axis. The views of Gerstäker, Möller and Reis are discussed, and the space group C_{4h}^3 suggested by them is rejected. The structure is worked out in some detail and illustrated by diagrams. H. N. A.

1443. More Elementary Treatment of the Hydrogen Atom in Wave Mechanics, Generalised for the Moving Nucleus. J. K. L. MacDonald. *Roy. Soc. Canada, Trans.* 22. *Sect.* 3. *pp.* 417–422, *May*, 1928.

It is shown that if the nucleus be allowed to move, Schrödinger's wave equation for the hydrogen atom is modified by the substitution of $\mu = 1 \Big/ \left\{ \frac{1}{m_n} + \frac{1}{m_e} \right\}$ for m_e, a similar modification to that required in the "classical quantum theory." The wave equation is then solved in detail by more familiar mathematical methods than are usually employed in wave mechanics. W. S. S.

1444. Theory of Electron Scattering and Excitation by Collision. J. Holtsmark. *Zeits. f. Physik*, 52. 7–8. *pp.* 485–495, 1928.

The analysis refers to a system consisting of a neutral hydrogen atom and a free electron (immovable nucleus, non-spinning electrons). A solution is constructed from the eigenfunctions of this system, satisfying the wave equation and reducing at infinity to a plane wave and scattered spherical waves. During the scattering process in general all the eigenfunctions of the atom are excited; such excitation can, however, be replaced by a distortion of the atomic field (polarisation of the atom). Permanent excitation can only occur for those eigenfunctions corresponding to excitation energies less than that of the bombarding electron. The scattered electrons for both elastic and inelastic collisions are representable as waves moving in a medium of refractive index determined by the field of the atom corresponding to its state after the collision. W. S. S.

1445. Isotopy of Lead. [Mrs.] B. Perrette-Montamat. *Ann. de Physique*, 10. *pp.* 349–407, *Nov.–Dec.*, 1928.

Ordinary lead, with atomic weight 207·2, and lead extracted from pitchblende, with atomic weight 206·4, have been investigated. The spectroscopic measurements of Merton have been repeated and extended; the difference in wave-length previously found has been confirmed, and a diminution of this difference noted in moving towards the ultra-violet; the difference for the 4058 Å. line of lead is of the order of 0·007 Å., with a precision of the order of 0·0008 Å., the lead of radioactive origin having the longer wave-length. The densities found for the metals were at 0°C., 11·336 ± 0·0004 for ordinary lead and 11·278 ± 0·0004 for the pitchblende lead. The densities of the crystallised nitrates at 0° were, 4·536 ± 0·0005 for ordinary lead and 4·523 ± 0·0005 for pitchblende lead; this shows that the molecular volumes of isotopic nitrates are equal. Measurements of the densities of saturated solutions of the nitrates have not given satisfactory results, apparently owing to the difficulty in obtaining exact saturation; the sign of the difference in density already noted has, however, been confirmed. The indices of refraction of both nitrates were found to be identical, being 1·78185 at 10° C. for the line λ = 5890 Å. H. N. A.

1446. "Packing Fractions" of Atoms and their Interpretation. A. C. Burton. *Roy. Soc. Canada, Trans.* 22. *Sect.* 3. *pp.* 379–395, *May*, 1928.

Concludes that, if in any two cases the addition of a certain number of protons and electrons to the nucleus in passing from one atom to another produces the same extra loss in mass, the addition has probably been made in the same way. For instance, in some cases the addition of $1p + 1e$ (one proton and one electron, a "neutron") gives an extra loss of mass of about 0·008, while in other cases, especially in the lighter elements, this loss is greater; it is assumed that in the first case the packing of the neutron is looser than in the second, and that it is a satellite revolving round a central nucleus; while in the second case it is firmly bound to the rest of the nucleus. In Li7 the neutron is loosely bound, although this is a light element. A graph of the packing per α-particle against the number of α-particles in the nucleus is given. The loss of mass per α-particle reaches a maximum for mass about 70, and falls again as the mass is further increased. The packing effect thus decreases, and for lead it is not much greater than that of an α-particle alone; further on it becomes less than this, and the forces binding the α-particles together must become small, which seems to be the case in the radioactive elements. The original paper should be consulted for further details.
H. N. A.

1447. Symmetrical Electronyls. P. Vinassa. *Accad. Lincei, Atti,* 7. *pp.* 880–885, *June* 1, 1928.

Develops the theory of electronyls [see Abstract 1503 (1928)] and deduces the rule that the maximum negative valency of any substance is given by the difference between the typical number of the immediately succeeding equilibrium and the atomic number. Noble elements like neon must be at least tetravalent. E. E. F. d'A.

1448. De-doubling of Roentgen and Optical Terms by Rotating Electrons. G. Gentile and E. Majorana. *Accad. Lincei, Atti,* 8. *pp.* 229–233, *Sept.*, 1928.

Fermi's potential not only permits a good *a priori* determination of the energy-levels of heavy atoms, but it also permits the de-doubling of the terms to be calculated with great exactitude, considering the statistical character of this theory of the atom; a circumstance which is of great importance, seeing that Sommerfeld's relativistic formulæ are not applicable. Calculations given for the Röntgen levels 3M of gadolinum and uranium, and for the optical terms of cæsium. Calculations also given for the intensity of the cæsium lines. A. D.

1449. Quantum Mechanics of Electrons in Crystal Lattices. F. Bloch. *Zeits. f. Physik,* 52. 7–8. *pp.* 555–600, 1928.

The motion of an electron in a lattice is investigated, the lattice being represented in the first place by a strictly threefold periodic field of force. Making use of Fermi statistics for the electrons the model allows of conclusions as to the part of the specific heat of the crystal which depends on the electrons. It is also shown that consideration of the thermal vibrations of the lattice makes it possible to obtain an order of magnitude and a relation to temperature for the electrical conductivity of metals which is in qualitative agreement with experimental effect. H. N. A

1450. Test for Schrödinger's Theory. Part II. J. L. Snoek, Jr. *Zeits. f. Physik*, 52. 9–10. *pp*. 654–656, 1928.

Repeats the measurements on the absorption of H_α and H_β recorded in Part I [see Abstract 61 (1929)], using different external conditions. The relation between H_β and H_γ under differing conditions has also been measured. The values found for the relations between the total absorptions, and for the double relation between the doublet components, agree in a satisfactory manner with the requirements of the theory. H. N. A.

1451. Functional Operators. L. Fantappiè. *Accad. Lincei, Atti*, 8. *pp*. 645–650, *Dec*. 16, 1928.

Physical quantities may (Heisenberg, Born, Jordan) be represented not only numerically, but also by infinite matrices; and Wiener and Schrödinger (undulatory mechanics) have shown that they may also be represented by linear functional operators. The author tests these conclusions by means of his analytical functions, applying to quantics. A. D.

1452. Degrees of Freedom in Wave Mechanics. V. S. Vrkljan. *Zeits. f. Physik*, 52. 9–10. *pp*. 735–738, 1928.

Although the motion of the electron in the hydrogen atom (without consideration of the concurrent movement of the nucleus) has 3° of freedom, yet in the undulation mechanics [see Abstract 2017 (1926)] the treatment need not include all of them, since the Bohr energy values can be derived when the problem is regarded as a case with 1° of freedom. When the motion of the nucleus is taken into account, the general problem has 6° of freedom, although this is also found reducible to the problem with 1° of freedom. H. H. Ho.

1453. Wave Groups and Wave Packets. L. Flamm. *Phys. Zeits*. 29. *pp*. 927–938, *Dec*. 15, 1928.

The author describes a mechanical model illustrating wave groups. The theory of wave groups and wave packets (waves limited in all directions, not only that of propagation), is developed in some detail for a simple special case with homogeneous wave propagation. The extension to the case of material waves is then made on the basis of Schrödinger's wave equation. The general integral of the wave equation for one-dimensional motion under no forces is shown to correspond in general to the flowing apart of any wave group which may exist initially (a result first obtained by Heisenberg). Further investigation shows however that certain integrals can be obtained which represent stationary wave groups. These latter are made up not of a continuous spectrum as the wave groups considered by Heisenberg, but of a number of lines obeying a given series formula. The conception of the material particle as a "solid" wave packet is shown by this investigation to be a possible hypothesis. W. S. S.

1454. Photonic Field and Dirac's Relativistic Generalisation of Wave Mechanics. T. de Donder. *Comptes Rendus*, 188. *pp*. 150–152, *Jan*. 7, 1929.

The author shows how Dirac's relativistic generalisation of wave mechanics can be derived from the equations of the "photonic field" [see *Ac. Roy. de Belgique, Bull. de la Cl. des Sciences*, 14. pp. 307–312, June, 1928]. The argument is based on a paper by Whittaker [see Abstract 1062 (1929)]. W. S. S.

1455. Three-Dimensional Motion of an Electron in the Field of a Non-Neutral Atom. M. A. Higab. *Phil. Mag.* 7. *pp.* 31–52, *Jan.*, 1929.

The author gives a comprehensive mathematical discussion of the motion of an electron in the combined field of an electric doublet and an electric charge (positive or negative) situated at the centre of the doublet. There are three types of motion, which are considered separately: (1) motion on a right circular cone, vertex at the charge and axis parallel to the doublet, (2) motion on a sphere, (3) general motion, where all the coordinates (polar) vary. The conditions for periodic orbits in the three cases are dealt with in detail. W. S. S.

1456. Dispersion Electrons of Lithium. J. Hargreaves. *Cambridge Phil. Soc., Proc.* 25. *pp.* 75–96, *Jan.*, 1929.

The first part of this paper gives a descriptive summary of the existing quantum theory of *f*, the number of dispersion electrons in the atom. The second part is an attempt to use Hartree's method of the "self-consistent" field [see Abstract 2918 (1928)], to estimate the number of dispersion electrons corresponding to the lines of the principal series of the optical spectrum of lithium and also to the continuous spectrum at the head of the series. The *f*-values obtained for the different lines and the continuous spectrum are reproduced in the following table, which also contains values due to Trumpy [see Abstract 3172 (1928)]:

n.	.	Trumpy's Value for *f*.	
2	0·7000	0·7230	Calculated
3	0·0104	0·0642	
4	0·0147	0·0195	Observed
5	0·0051	0·0087	
6	0·0030	0·0047	
7	0·0020	0·0028	
8	0·0013	0·0019	
9	0·0009	0·0013	
10	0·0007	0·0009	
$\sum_{10}^{\infty} f$	0·0035		
$\int_0^{-\infty} \frac{df}{d\epsilon} d\epsilon$ continuous spectrum	0·2562		
Total	$f = 0{\cdot}998$		

The following points are noteworthy: (1) the first line is very much stronger than the others; (2) the second line is weaker than the third; (3) the curve of $\frac{df}{d\epsilon}$ in the continuous spectrum has a maximum just beyond the head of the series. W. S. S.

1457. Tensorial Form of Dirac's Wave Equations. G. Temple. *Roy. Soc., Proc.* 122. *pp.* 352–357, *Jan.* 1, 1929.

The author points out that, since Dirac's wave functions are not the components of a tensor and his wave equations are not in tensorial form, his theory cannot be upheld without abandoning the theory of relativity. A system of wave equations is formulated possessing the same advantages as those of Dirac, and which are tensorial in form, in accordance with the general theory of relativity. H. N. A.

1458. Basis of Statistical Quantum Mechanics. P. A. M. Dirac. *Cambridge Phil. Soc., Proc.* 25. *pp.* 62–66, *Jan.,* 1929.

The author considers an *ensemble* of systems in Gibbs' sense. Classically each system is represented by a point in the 2n-dimensional phase space and statistics is concerned with the laws of motion of the dust of points, corresponding to the ensemble. On the quantum theory, each system has to be described by a wave function ψ, which can, however, be expanded in terms of a set of normalised orthogonal ψ_m's, thus $\psi = \Sigma c_m \psi_m$. If the number of ψ_m's is N, the ensemble is representable by a dust of points in the N-dimensional space of the c_m's. N is in general much greater than n and is infinite in most practical cases. Quantum mechanics, however, only allows the calculation of average values and when this is taken into account, it is shown that the motion of the dust is adequately described by means of a matrix ρ, the elements of which are functions of only 2n variables. ρ is analogous to the density function in the phase space of classical statistics. W. S. S.

1459. Gravity Determinations. Cecilia Dainotti. *Accad. Sci. Torino, Atti,* 63. 15A. *pp.* 365–374, 1927–1928.

Calculations of the force of gravity at a pole and at the equator from coupled observations of the force at various latitudes. A. D.

1460. Normal Gravity. G. Silva. *Accad. Lincei, Atti,* 8. *pp.* 691–696, *Dec.* 16, 1928.

Discusses the definitions of normal gravity. A. D.

METEOROLOGY AND GEOPHYSICS.

1461. Altitude of Ozone Layer. J. C. McLennan, R. Ruedy and (Mrs.) V. Krotkov. *Roy. Soc. Canada, Trans.* 22. *Sect.* 3. *pp.* 293–301, *May,* 1928.

Spectrograms of the zenith of the clear sky were made at Toronto in 1927–28 with a small Hilger quartz spectrograph in the time of about 1½ hours after sunrise and preceding sunset. The density of the ultra-violet part containing the Huggins bands was studied by means of the Moll self-registering microphotometer. The results obtained for the height of the ozone layer are slightly higher than those found by Cabannes and Dufay [see Abstract 2229 (1927)]. R. S. R.

1462. Fog and Haze, their Causes and Distribution, and Forecasting. H. C. Willett. *Monthly Weather Rev.* 56. *pp.* 435–468, *Nov.,* 1928.

The author summarises the results obtained hitherto on the nuclei of condensation, particularly those of Aitken and Köhler on hygroscopic nuclei, and the evidence favouring the theory that condensation begins on hygroscopic nuclei rather than on ions or neutral dust particles. Fogs are classified generally as air mass or frontal fogs. The former are subdivided into (1) advection types, due to the transport of warm air over cold surfaces, or of cold air over warm water surfaces; (2) radiation types, where an inversion exists with clear skies above; and (3) maritime fogs, caused by cooling of maritime transitional air over land surfaces. The latter are subdivided into prefrontal, front passage and post-frontal fogs. The causes, characteristics and distribution of each type of fog are considered according to Bergen methods of air mass analysis. From these statements of air mass properties the fundamental principles to be followed in fog forecasting are laid down. Finally, the bearings of fog frequencies and type of exposure on the choice of an aerodrome site are examined. R. S. R.

1463. Influence of Temperature on Composition of the Atmosphere in the Highest Levels. Helge Petersen. *Phys. Zeits.* 29. *pp.* 879–884, *Dec.* 1, 1928.

The assumption that diffusion determines the composition of the atmosphere in the upper levels leads to the result that above 200 km. He is almost exclusively present. This is in disagreement with auroral observations at those levels, since no He lines are found in the spectrum. Calculations based on partial pressures at the surface also gave too little He, while the possibility of scattering of He in space by thermal movement of the molecule is discounted by the low temperature of the stratosphere. A state of diffusion equilibrium is probably reached, but difficulties arise in the calculation from uncertainties in the kinetic theory of gases, the determination of the He content and He radiation from the earth. The scattering of the He molecules is due to corpuscular radiation from the sun striking individual molecules but not heating the layers considered to the high temperatures necessary according to the kinetic theory of gases. In comparison with the energy in the corpuscular stream, very little is absorbed in this way. R. S. R.

1464. International Cooperation for Auroral Research. C. Störmer. *Roy. Astron. Soc. Canada, J.* 23. *pp.* 1–7, *Jan.,* 1929.

The author explains the use of photographic methods in fixing the form, extent and height of the aurora. For international cooperation, an atlas with typical auroral forms has been prepared. By adopting this the frequency, height and situation of different auroral forms can be obtained as functions of time and place, and also the heights of auroral rays by day and night. If photographic stations can be established around the auroral belt, information will become available of the times of variation of the various forms of the aurora, and so assist in the discussion of theories of the aurora. R. S. R.

1465. Partial Differential Equation of Second Order occurring in the Theory of Earth Pressure. C. W. Oseen. *Arkiv f. Mat. Astron. och Fysik, Stockholm,* 20. 25. *pp.* 1–27, 1928. *In German.*

After a statement of the conditions of equilibrium, the author obtains the equations for equilibrium in the two-dimensional case. These are then transformed into a partial differential equation as in the previous paper [see Abstract 1418 (1929)]. The paper is wholly mathematical. R. S. R.

1466. Geodetic Constants. W. D. Lambert. *Washington Acad. Sci., J.* 18. *pp.* 571–576, *Dec.* 19, 1928.

Starting from the figures adopted by the International Geodetic and Geophysical Union in 1924, the author introduces a longitude term into the formula for *g* to account for the apparent systematic differences in gravity on land and at sea. This also gives, for the figure of the earth, an ellipsoid with three unequal axes. Other evidence by Clark, Helmert and Heiskanen supports this view. R. S. R.

1467. Tides in Oceans on a Rotating Globe. Part II. G. R. Goldsbrough. *Roy. Soc., Proc.* 122. *pp.* 228–245, *Jan.* 1, 1929.

The method used in Part I [see Abstract 1194 (1928)] finds a ready application to certain cases of tidal waves in flat rotating seas. The case is first discussed of a semicircular basin in which the law of depth is $h_0(1 - r^2/a^2)$, so that the bottom shelves from the centre to the circumferential edge. Complete results are given for a certain depth and the positions of the rotating nodal line, corresponding to the lowest normal mode, are shown in a diagram. The solution is expressed in terms of a certain type of hypergeometric function. It is further shown that, by an extension of the same method, it is possible to solve the case of a sectorial basin of any angle with the same law of depth. This problem has been already completely solved by Proudman, whose method is shorter, but the present solution is worthy of inclusion because of its analytical interest. H. H. Ho.

1468. Ellipticity of the Terrestrial Equator. T. Banachiewicz. *Comptes Rendus*, 188. *pp.* 46–47, *Jan.* 2, 1929.

The author shows that Bossolasco's contention, contained in a recent paper [Abstract 736 (1929)], *viz.*, that the equatorial terrestrial ellipse as derived by Helmert and others should be rotated through 90° in order to conform with measurements of gravity, is invalid. J. S. G. T.

1469. Ellipticity of the Terrestrial Equator. M. Bossolasco. *Comptes Rendus*, 188. *pp.* 238–240, *Jan.* 14, 1929.

The author replies to criticism by Banachiewicz of a statement made in a previous paper, *viz.*, that the terrestrial equatorial ellipse, deduced from gravimetric determinations, should be drawn, not along the Greenwich meridian, but exactly normal to that direction [see Abstract 736 (1929)]. Banachiewicz's argument is based upon well-known considerations which were unjustifiably introduced for purposes of simplification. J. S. G. T.

ASTROPHYSICS.

1470. Amount of Solar Radiation that Reaches the Surface of the Earth on Land and Sea, and Methods by which it is Measured. H. H. Kimball. *Monthly Weather Rev.* 56. *pp.* 393–399, *Oct.*, 1928.

Since the observations of solar radiation at sea are very few, the author has sought to compute the mean solar radiation intensities from such data as exist for inland and coastal stations. A solar spectrum energy curve is obtained after passage through air for pressures between 40 and 76 cm. Hg and for different zenithal distances. The atmospheric transparency is calculated for direct and diffuse radiation for different latitudes and corrected for turbidity. Finally, isopleths are given for the whole globe of the total solar radiation (direct + diffuse) for (1) cloudless skies on June 21 and December 21, and (2) average cloudliness on March 21, June 21, September 22 and December 21. R. S. R.

1471. New Analysis of Sunspot Numbers. D. Alter. *Monthly Weather Rev.* 56. *pp.* 399–401, *Oct.*, 1928.

Former analyses of sunspot numbers were unsatisfactory in attempting to prove the existence or non-existence of fairly constant periodicities because the data were too few. The author used the equations developed in the correlation periodogram for this purpose, and the periodogram obtained is reproduced. It shows an average period of 11·37 years, with a varying amplitude, which has a minimum at 33 years, a maximum at 65 to 70 and a pronounced minimum at 126 years. An investigation of superimposed periodicities is made. In discussing explanations the author considers planetary tides too feeble in comparison with the sun's gravitational field to explain sunspots. Since studies of radiation pressure and of the solar spectrum indicate an almost perfect balance of forces in the solar atmosphere, small tidal effects may produce large effects.

R. S. R.

1472. Periods of Solar and Terrestrial Phenomena. H. Fritz. *Monthly Weather Rev.* 56. *pp.* 401–407, *Oct.*, 1928.

The author has investigated a very large number of periods for solar and terrestrial phenomena. In tables are compared the sunspot observations, auroral observations, good vintage years in Germany, Austria and Switzerland, and years of heavy falls of hail. The maxima of these phenomena indicate an interval of 11 years and an epoch period of 55·3 years. The author concludes that the resultant curves of the series of observations are made up of individual primary curves of unequal lengths and amplitudes. It is considered that the individual waves are caused by the planets. On account of mass and distance, Jupiter, Venus, Mercury and the earth are most disturbing, Saturn and the other planets less so. The inner planets are related chiefly to the shorter and the outer planets to the longer waves. The probable influence of comets, meteor swarms, or even the sun and its system in space can be largely eliminated. R. S. R.

1473. Distribution of Energy near the Limb of the Sun. M. Minnaert. *Roy. Astron. Soc., M.N.* 89. *pp.* 197–207, *Dec.*, 1928.

For many years it has been believed that the brightness of the sun's disc decreases gradually towards the limb, but there falls off very suddenly. The recent measures of Moll, Burger and van der Bilt throw doubt upon this belief, and in a paper by Kienle and Juska it is positively contradicted. The best observers, however, cannot avoid being misled by scintillation, which blots out the sharp limb of the sun. A real decision can only be obtained by observations during eclipse, using the method of Julius. More measurements by this method are desirable, but from existing data, and especially the observations of Julius and Moll in 1912, the conclusion is drawn that there is a very sudden fall in brightness at the sun's limb. M. A. E.

1474. Greenwich Observations of the Sun and the Four Outer Planets from 1901-1928. F. W. Dyson and R. T. Cullen. *Roy. Astron. Soc., M.N.* 89. *pp.* 256–264, *Jan.*, 1929.

1475. Fundamental Formula of Astrophysics: Calculation of Colour Index. G. Tiercy. *Arch. des Sciences*, 10. *pp.* 363–379, *Nov.–Dec.*, 1928.

The author deals with the colour index (I) of a star as the difference of the magnitude obtained by photographic and visual photometry. This difference depends on differences in the spectral energy distribution of the light emitted by the star. From studies of the variation of one Cepheid the author gives $0 \cdot 8191 = \log R + 0 \cdot 2\, M_v - 0 \cdot 515$, but this is inaccurate when applied to all spectral types. The last term is then considered as a function of the spectral type and perhaps of the radiation from the star, and its value is determined in several cases. R. S. R.

1476. Excitation of Line and Band Spectra in Comets by Sunlight. H. Zanstra. *Roy. Astron. Soc., M.N.* 89. *pp.* 178–197, *Dec.,* 1928.

The explanation of the continuous spectrum of comets as due to reflection of sunlight by solid particles in the head is generally accepted as satisfactory; but the line and band spectrum must be of a different nature. It has usually been assumed that these spectra are produced by electrical excitation similar to that causing such spectra in a discharge tube. A different mechanism is here suggested, namely, the absorption of sunlight by the gases in a comet's head and subsequent re-emission of the same wave-length (resonance), or a longer wave-length (fluorescence). This was first proposed by Schwarzschild and Kron for comets' tails, and it is here shown that it is also sufficient to explain the intensity observed in the spectra of comets' heads wherever a check is possible. M. A. E.

1477. Photometric Studies of Luminosity and Colour Effects in Short Stellar Spectra. Y. Öhman. *Arkiv f. Mat. Astron. och Fysik, Stockholm,* 20. 23. *pp.* 1–41, 1928. *In English.*

An investigation by the author of the Siegbahn and Schilt photometers in the determination of absolute magnitudes of late and early spectra by short objective prism spectra. He describes the apparatus and spectrophotometric methods; the spectra of the Siegbahn photometer were widened by five superposed broadenings and used only for bright stars of late type; the broadening of spectra for the Schilt photometer was by two methods, for stars in low declination and for polar stars. One hundred and two diagrams of 33 stars were analysed by the Siegbahn, and a figure is given of a typical density diagram of a G5 giant. The spectral regions studied are the colour-luminosity effects in G – λ4383, λ4227 – G and λλ4144–4184. A table is given for results by the Schilt photometer from 77 late-type stars in the Greenwich polar zone where G*m* is the difference in magnitude between λλ4138–4173 and λλ4326–4368, and C*m* is that for λλ4138–4173 and λλ4232–4272, and from these quantities the absolute visual magnitude is calculated by the help of Lindblad's luminosity diagrams. A comparison is given of the measurements of bright late-type stars with Mt. Wilson absolute magnitudes which indicate a somewhat higher precision than Lindblad's. He finds that the measurements of line-strengths of B- and A-type stars with the Schilt photometer yield a method which is entirely equivalent to the Upsala classification for these types. A. S. D. M.

1478. Bolometric Magnitudes in the Cluster Messier 37. A. Wallenquist. *Arkiv f. Mat. Astron. och Fysik, Stockholm,* 20. 26. *pp.* 1–14, 1928. *In English.*

A method has been developed by v. Zeipel of determining the mean masses of groups of stars from their distribution in a star cluster. This is based on the Maxwellian law of distribution for the state of a gaseous mass in statistical equilibrium. Applying his method to Messier 37 he and Lindgren have derived the mass ratio for five different colour-types of stars. Eddington has shown that there is a relation between the absolute bolometric magnitude of a star and its mass, and would have preferred a grouping according to the bolometric magnitudes in the above-mentioned investigation (*M.N.* 84. p. 162). The writer has, therefore, worked out the mean masses of four groups of stars, with special regard to the bolometric magnitudes, on the basis of v. Zeipel's theory and his photometric work on the cluster. The results, and also those of v. Zeipel, are compared with Eddington's theory, and the former show unexpectedly great deviations, while those of v. Zeipel are in striking harmony with Eddington. When determining masses by v. Zeipel's method, therefore, it seems to be better to group the stars by magnitude and colour index, rather than by bolometric magnitude, probably because in the latter case the influence of stars in the background cannot be entirely eliminated. M. A. E.

1479. Dynamics of Stellar System. B. Lindblad. *Arkiv f. Mat. Astron. och Fysik, Stockholm,* **21.** 3. *pp.* 1–28, 1928. *In English.*

An investigation of the local cluster showing that it cannot have the property of ellipsoidal star-streaming if this involves that it is a dynamically closed system. The author discusses the galactical system as two-dimensional and writes its general frequency function, $f(\omega, \theta', \Pi, \odot; t)\omega d\theta d\omega d\Pi d\underline{\odot}$, where ω, θ are polar co-ordinates round the system's centre of gravity, and Π, $\underline{\odot}$, the corresponding linear velocities, t is the time, and $\theta' = \theta - xt$. He develops this and finds that the tangential force must be zero or else the enormous flattening in the system is inexplicable as a property of a steady state, and that the elements of a certain mass are distributed along a certain orbit in a regular way or otherwise the orbits would not be closed curves. The curves of constant distribution in the Π, $\underline{\odot}$-plane are approximately ellipses, and the ratio of their semi-axes is very nearly the observed ratio of the two axes of the velocity-ellipsoid in the galactic plane. He considers the asymmetrical drift of mean centroidal velocities with increasing velocity dispersion and finds the sun as about 14 % of the radius inside the galactical limiting circle, and his period of revolution as 150 million years; the mass within the sun's orbit as $8 \cdot 10^{10}\odot$; and the total mass as $13 \cdot 10^{10}\odot$. He finds a spiral motion at the system's edge, possibly due to slight tidal forces outside. In his cosmogonic considerations he takes the stars as individuals of great permanence surviving the violent changes of their stellar systems; those being now formed are the massive stars of the central galactic stratum. The series of " anagalactic " nebulæ—spherical, elliptical and spiral—is not (he says) a series of evolution towards greater flattening, nor from general gaseous to stellar conditions, but rather a series of similar systems (on the whole) of different angular momenta; and the spiral structure is a natural consequence of the great flattening of some systems, and to be considered in general as a periodic phenomenon, since the matter of the spiral arms returns again to the " mother system." [See Abstract 2688 (1927).] A. S. D. M.

1480. Distribution of Restricted Proper Motions. W. M. Smart. *Roy. Astron. Soc., M.N.* 89. *pp.* 93–104, *Nov.*, 1928.

In any region of the sky the distribution, according to position angle, of proper motions limited to a particular minimum value is distinct from the distribution when no restriction is imposed. With Dyson's law of stellar density the effect of this restriction on the character of the true drift-curves has been derived and the results tabulated. In practical applications, the restricted distribution can hardly be differentiated from a true drift-curve with a velocity, however, considerably greater than the real velocity of the complete drift of stars. The systematic motions of the stars (with proper motions exceeding 20″ per century) discussed by Dyson 20 years ago are examined in relation to the theoretical implications of the paper. R. S. R.

1481. Asteroidal Perturbation. T. C. Hudson. *Roy. Astron. Soc., M.N.* 89. *pp.* 133–138, *Nov.*, 1928.

The author obtains by vectorial analysis the results of an investigation concerning a selected portion of that gross alteration of state of an orbit of an infinitesimal planet which is affected by the long-continued action of one planet Jupiter moving in a fixed ellipse. The expression obtained cannot cancel out with terms obtained in further approximation where account is taken of higher orders of Jovian mass and eccentricity and it is independent of the cyclic term which depends on the eccentricity of the orbit of the asteroid itself. R. S. R.

1482. Photovisual Magnitudes of Southern Stars, with Revised Values for Northern Stars. E. S. King. *Harvard Coll. Astron. Obs. Ann.* 85. 10. *pp.* 181–190, 1928.

Photovisual magnitudes for 24 stars were given in Harvard Annals in 1919, and for 100 stars in 1923 [see Abstract 792 (1924)], and it was stated that observations had been begun at Arequipa of selected southern stars. The programme suffered a long interruption, and had not been completed when the Arequipa station was closed, but the results of sixteen plates are here given. In a table of 123 stars the photovisual magnitude and the spectrum of each are shown and also the difference between its photovisual and photometric magnitude. The results indicate, as before, a decreasing difference as the stars become redder. The photovisual magnitude of Polaris is now determined to be 2·01, previous determinations having been 2·02 and 1·99. M. A. E.

1483. Absolute Magnitude of Long-Period Variables. H. Shapley. *Nat. Acad. Sci., Proc.* 14. *pp.* 958–962, *Dec.*, 1928.

Long-Period variables are widely scattered in the sky, are in the earliest stage of stellar evolution, have exceedingly low density, and apparently the lowest effective temperatures known. The author investigates their mean absolute magnitude ($\overline{M}$) at maximum, the dispersion about that mean, and the dependence of absolute luminosity on period and range; by means of the Southern Cluster 47 Tucanæ (giving $\overline{M} = -2\cdot0$); by the motions of the brighter galactic stars (Wilson and Merrill obtaining $\overline{M} = 0\cdot0$ and Oort, $\overline{M} = -2\cdot0$) [see following Abstract]; and especially by the 450 variables of all kinds in the Milky Way Field 185. These last are important, and yield apparent *photographic* magnitude at maximum of 14·8 (visual $M = -2\cdot5$), thus supporting the values from 47 Toucanæ, and from Oort and Gerasimovič. He shows that it is not tenable to suppose that M.W.F. 185 contains two different star clouds—cluster-type Cepheids and Long-Period variables—widely separated in the line of sight, or that the cluster-type Cepheids are low luminosity class A stars of $\overline{M} = +2\cdot5$ or fainter. He gives diagrams showing the frequencies of periods and of maximum magnitudes for the Long-Period variables in M.W.F. 185; the distribution appears to be so closely normal that the mean value 148, with a dispersion of 1·0, may be taken as their luminosity, and there is indication of the existence of a definite galactic nucleus—the same as for the cluster type Cepheids. The moderate dispersion shows that the Long-Period variables will serve well for the measurement of galactic distances. A. S. D. M.

1484. Absolute Magnitudes of Long-Period Variables. B. P. Gerasimovič. *Nat. Acad. Sci., Proc.* 14. *pp.* 963–968, *Dec.*, 1928.

A large percentage of faint galactic variables are Long-Period variables or of eclipsing type. The author discusses the Me stars absolute magnitude (M) as found by Merrill and Strömberg, by Wilson, and by Oort; and the period-luminosity relation which, if valid, may not have the same theoretical value as the Cepheid law. For the determination of $\overline{M}$, the Me variables are divided into three groups of I(90–250), II(250–340), and III (greater than 340) periods in days. For these three groups the author gives values for the parallactic and peculiar tangential motion, for solar motion and peculiar radial velocity, for parallaxes and absolute visual magnitude. He finds that the high velocities (> 80 km. per sec.) characteristic of Me variables do not occur in group III; in II and III the K term is illusory, and its high value in I is due to a few high velocity stars; that there is a strong positive correlation between period and spectrum and when stars are grouped according to period, changes in V_0 and $\overline{\theta}$ are more pronounced than if spectral subtype is chosen as the correlation variable; that the rôle of the period in their kinematical properties is pronounced; and that the solar speed and residual velocity increase in I and decrease in longer periods; that Long-Period variables are among the most luminous objects, like F super-giants and early B stars; that probably there is a mixture of swiftly and slowly moving stars. For II Me variables he obtains $\overline{M} = -0\cdot6$. A. S. D. M.

1485. Consequence of Property of Diffraction by a Circular Aperture. M. Hamy. *Comptes Rendus*, 187. *pp.* 1089–1092, *Dec.* 10, 1928.

From a previous note [see Abstract 1097 (1929)] the author shows that in spite of complex diffraction effects the virtual image of the limb of a heavenly body, such that the observer views it through the eyepiece, has an optical constitution and brightness, and therefore an invariable aspect when the aperture of the diaphragm is varied. He applies this property to the measurement of the diameter of a heavenly body, and obtains the equation $\Delta + \delta\,\text{Æ} = (2t_1 - t_2)\cos\Omega$, where Δ is the true diameter of the heavenly body, $\delta\,\text{Æ}$ is the variation of right ascension, Ω is its declination, and t_1, t_2 are the times of transit of the body when the diameter of the diaphragm is the whole and the half of the telescope aperture. This can, however, only be put in operation when the images are quite steady atmospherically, when the appearance is the same in both observations, and an impersonal micrometer is used. A. S. D. M.

1486. Frequency Law of Stellar Velocities and Relationship between Absolute Magnitude and Absolute Velocity of G-Type Stars. J. M. Mohr. *Comptes Rendus*, 187. *pp.* 1128–1130, *Dec.* 10, 1928.

The author finds that 519 G stars agree with the Adams-Strömberg-Joy law for K stars, but differ from Maxwell's. He gives constants for the first-mentioned frequency law, and obtains

$$F(\nu) = 2\cdot281 \text{ mod } (\sqrt{\pi}\nu)^{-1} \left(e^{-2\cdot281^2 (\log \nu - 1\cdot4110)^2}\right) \text{ for G giants; and}$$

$$F(\nu) = 2\cdot652 \text{ mod } (\sqrt{\pi}\nu)^{-1} \left(e^{-2\cdot612^2 (\log \nu - 1\cdot6811)^2}\right) \text{ for G dwarfs,}$$

where the log of ν is to the base 10 and mod. $= 0\cdot 43429$. He points out that the relationship between the absolute magnitude (M) and absolute velocity (ν) as given by the Eddington-Douglas formula ($\nu = a + b\mathrm{M}$) and by the Adams-Strömberg-Joy formula ($\log \nu = a + b\mathrm{M}$) gives nearly the same results; for all stars the increase of one magnitude gives an increase of 5·6 km. absolute velocity. From a table of mean magnitudes and velocities he finds that the brightest stars have the smallest mean velocity (about 20 km.); the most feeble stars, the greatest mean velocity (about 80 km.); between limits of absolute magnitude $-1\cdot 4$ and $+2\cdot 5$, there is a mean and nearly constant velocity of 33 km. A. S. D. M.

1487. Rotation Period of Venus. A. Jarry-Desloges. *Comptes Rendus*, 187. *pp.* 1130–1132, *Dec.* 10, 1928.

From observations made at Sétif in 1913, 1920 and 1922, Fournier determined the position of the polar axis of Venus, which simplifies the problem of the period, though this is difficult because of the instability of the planet's atmosphere and the lack of any permanent feature. In 1922, however, there was much detail visible, and it was deduced that the rotation period lay between 20 h. 29 m. and 24 h. 37 m., which was later corrected to 23 h. 53 m. This last implies stability during a terrestrial day, which is, however, far from certain. A. S. D. M.

1488. Limiting Density in White Dwarf Stars. E. C. Stoner. *Phil. Mag.* 7. *pp.* 63–70, *Jan.*, 1929.

Using the Fermi statistics, it is shown that, under the influence of gravitational and electron "packing" effects, the limiting density ρ of a uniform sphere of mass M, consisting of a mixture of fully-ionised atoms, is approximately given by $\rho = 3\cdot 85 \times 10^6(\mathrm{M}/\mathrm{M}_s)^2$, where M_s is the mass of the sun. For spheres with the masses of Sirius B and O_2 Eridani B, the limiting densities are $2\cdot 8 \times 10^6$ and $7\cdot 5 \times 10^5$. It is suggested that white dwarfs contain a core of material approaching the limiting density, the ratios of the radius of the core to the radius of the star, in the two cases considered, being about 0·25 and 0·61. The core will be in an almost incompressible or "quasi-liquid" state, due to the "congestion" of the electrons. Jean's theory of the distribution of stars in the Russell temperature-luminosity diagram is briefly discussed, and it is shown that the quasi-liquid state required for stability may be attained in white dwarfs, owing simply to electron packing, without the necessity of assuming "jamming," of the few remaining K-ring atoms. H. H. Ho.

1489. Exact Time in Astronomy. Jean Boccardi. *Washington Acad. Sci., J.* 18. *pp.* 565–571, *Dec.* 19, 1928.

The author details the conditions which are favourable to the attainment of an accuracy of 0·01 sec. in time determinations and in predicting corrections to be applied to readings of a good clock. For the former he advises instruments with broken telescopes and capable of reversal in a few seconds, a diameter of the objective of 7 to 10 cm., the selection of a few stars for each observatory, and accuracy in finding their right ascensions, perfect use of the impersonal micrometer, and good levels read with all precautions. For the latter, he discusses possible errors with Riefler clocks. R. S. R.

LIGHT.

1490. Optical Transparency of Ultra-Violet Transmitting Glasses after Exposure to X-Rays and Ultra-Violet Light. G. M. Shrum, C. G. Patten and H. D. Smith. *Roy. Soc. Canada, Trans.* 22. *Sect.* 3. *pp.* 433–436, *May*, 1928.

Samples of proprietary glasses having a high transparency to ultra-violet light have been submitted to the action of ultra-violet light and X-rays. With ultra-violet light a strong luminescence lasting 1 to 2 hours was excited, and the ultra-violet transparency was increased after the cessation of the luminescence. Heat is stated not to affect transparency. With X-rays thermo-luminescence was excited and coloration of the glass, which disappeared at low temperatures. Optical transparency was lowered, but not owing to the coloration, and loss of transparency persisted after the coloration was lost. The effects produced are discussed on the basis of a photochemical oxidation. B. J. L.

1491. Photographic Measurements of Absorption in the Ultra-Violet. V. Hardung. *Helv. Phys. Acta*, 1. 7–8. *pp.* 472–507, 1928. *In German.*

Two photographic methods for the measurement of light absorption were examined in order to ascertain their accuracy and reproducibility. The first method was substantially the same as that developed by Henri, but used in conjunction with the rotating sector to give the requisite variations in the exposure times. The second method, which is termed the microphotometer method because it involves the use of the Moll microphotometer, differs from the first in that it allows of direct estimation, by interpolation, of the intensity connection of the two spectra. This is obtained from an intensity blackening curve for each wave-length which is photographed directly on to the plate. The method has the further advantage of being independent of the method of development and the properties of the emulsion. As examples of the applications of the two methods, the following problems were examined: (1) measurement of the absorption of betaine and related compounds; (2) measurement of the absorption of ultra-violet glasses; and (3) an attempt to find a connection between the benzol spectrum and temperature. The results for betaine, glycocoll and corresponding HCl combinations obtained from both methods, neither supported nor opposed the Pfeiffer theory of the betaine structure. From a comparison of two types of ultra-violet glasses with normal window glass, it is shown that the ultra-violet glasses are greatly superior, having a 50 % transmission at 3000 Å. compared with total absorption by the window glass. No connection could be found between the benzol spectrum and temperature, but the results, which were obtained using both methods, showed that within the limits of experimental error these gave identical results. R. C. F.

1492. Normal and Abnormal Colour Vision. F. Allen, D. C. Archibald and R. A. Lind. *J.O.S.A. and R.S.I.* 18. *pp.* 1–16, *Jan.*, 1929.

In this communication the nervous actions underlying vision are briefly discussed. These are the conduction of the impulses from the stimulated receptors by the afferent nerves to the visual centres in the cortex, and the immediate release of enhancing and inhibiting impulses which are conducted by the efferent nerves to the retina where they control the sensitivity of the receptors. Normal vision is the result of a perfect balance of these actions. When the enhancing actions are very weak, or the inhibitory actions strongly developed, colour defectiveness or blindness results. When the enhancing activities are predominant, anomalous trichromatic vision is produced. Both varieties of abnormal vision may comprise many types according to the number of primary sensations affected. Comparative curves of normal and both kinds of abnormal vision have been obtained by typical observers which experimentally verify these principles. It thus becomes possible to embrace all types of colour vision under one theory of nervous action. AUTHORS.

1493. Measurement of Reflecting Power of Opaque Minerals and of Very Refringent Transparent Minerals. J. Orcel. *Comptes Rendus*, 187. *pp.* 1055–1057, *Dec.* 3, 1928.

For the metals Pt and Ag and for the isotropic minerals diamond, galena and blend the refractive index, coefficient of absorption and reflecting power are tabulated in order that these may be used as standards. An expression is derived in terms of the ellipticity of the incident and reflected light which gives a measure of the rotation of the plane of polarisation [see Abstract 592 (1928)]. R. S. R.

1494. Index of Refraction of a Liquid. O. Specchia. *Accad. Sci. Torino, Atti*, 63. 11*a*–14*a*, *pp.* 253–258, 1927–1928.

A method, based on that of Williams and Brace, for measuring the index of refraction of a liquid by means of the prismatic laminæ of Fabry and Perot. A. D.

1495. Indices of Refraction of a Mesomorphic Substance in the Solid State. Jacqueline Zadoc-Kahn. *Comptes Rendus*, 187. *pp.* 1138–1139, *Dec.* 10, 1928.

The author, with the help of the microtome, cut prisms from large crystals of para-azoxyanisol such that the bisecting face contained two axes of optical elasticity and the edge parallel to one of them. At minimum deviation each prism gives two out of three of the principal indices of refraction. The results obtained are tabulated. R. S. R.

1496. Birefringence and Dichroism of Thin Layers of Iron obtained by Distillation. M. Cau. *Comptes Rendus*, 188. *pp.* 57–58, *Jan.* 2, 1929.

Further properties of these films have been established. Rotation of the film produces a corresponding change of the rotation (R) and ellipticity (E) in the film. When tested in the central part of the visible spectrum the dispersion is normal for E, but anomalous for R, and approaches that with the Faraday effect. There is a qualitative increase of the effect as the film becomes thicker or is nearer to the wire producing the film. The Faraday effect for these thin films is hard to measure, as its magnitude is near to the errors of experimental measurements. The variations of R and E in light reflected from the layers for different angles of incidence are stated [see Abstract 2103 (1928)]. R. S. R.

1497. Dispersion of Double Refraction in Quartz. F. C. Harris. *Phil. Mag.* 7. *pp.* 80–85, *Jan.*, 1929.

The retardation of photoelastic effects due to pressure was investigated by means of a pair of quartz wedges, the thickness of the transmitting layer being varied by sliding one plate over the other. It was, therefore, essential that the dispersion of double refraction in the quartz be measured for a large number of wave-lengths, and the results are recorded in this paper. Fifty-seven bands were examined according to the experimental and mathematical treatment outlined, and the results are incorporated in a series of tables. S. G. B.

1498. Trichromatic Colorimeter with Spectral Primaries. W. D. Wright. *Optical Soc., Trans.* 29. 5. *pp.* 225–241; *Disc.*, 241–242, 1927–1928.

For the purpose of accurately redetermining the locus of the spectral colours in the colour triangle of numerous observers a special trichromatic colorimeter was developed. This paper deals with the optical system and the design of the instrument, together with the adjustment, calibration and method of eliminating stray light. The two necessary spectra [see Abstract 1002 (1926)] are produced by the same spectrometer system, and from one of these spectra the three portions which are to act as the primaries are reflected back through a lower part of the dispersing system. Thus, the mixing of the three primaries is effected by neutralising the prismatic dispersion introduced in their formation. The test colour and a desaturating colour are obtained from the other spectrum and mixed together in the same manner, the composite beams then being brought into the two halves of a simple bipartite field. This method of mixing ensures that each colour is filtered in its return passage through the dispersing system, and also has the effect of removing stray light. The intensities of the three primaries are controlled by gelatine photometer wedges, whilst the Maxwellian method of observing the field is used and obtained without introducing rotating parts into the system. In the *Discussion*, **J. Guild** said that the use of wedges was unfortunate, although necessary, because no other satisfactory method had been developed. Further, the use of the equivalent of a fairly wide slit at the observer's eye might lead to trouble with regard to the test colour, and the author might find it necessary to restrict his slit, using a rotating lens spreader to give the desired width of exit pupil. For use in industrial laboratories the instrument described had many disadvantages, mainly in adjustments and calibration, which are eliminated in coloured filter colorimeters.

R. C. F.

1499. Echelon Spectroscopes. V. Ronchi. *N. Cimento*, 5. *pp.* 413–415, *Dec.*, 1928.

Gives two methods of determining the direction in which the wavelengths diminish in a spectrum observed in an echelon spectroscope. One of these depends upon the curvature when that is appreciable. The other depends on the minimum deviation of the lines when the grating is inclined. E. E. F. d'A.

1500. High Dispersion Prism Spectra. J. Evershed. *Roy. Astron. Soc., M.N.* 89. *pp.* 175–178, *Dec.*, 1928.

Particulars are given of several devices which have been used to obtain greater dispersion in the red for photography of the sun in H_α and for studies of line-of-sight motions in prominences and sunspots. Prisms were first used in an auto-collimating Littrow spectrograph with a plane mirror to return the light. Later a 30° reflecting prism replaced the mirror.

This gave dispersion equal to that of the 3rd order spectra for a grating of 15,000 lines per in., and had a linear dispersion of 1 mm./A°. For line-of-sight movement in sunspots in the region H_β and H_γ a hollow prism containing purified ethyl cimmamate was used. R. S. R.

1501. Optical Procedure for Testing Polished Surfaces and its Application for Measurements of Radii of Curvature. A. Arnulf. *Comptes Rendus,* 187. *pp.* 1044–1046, *Dec.* 3, 1928.

The author uses a microscope to view two sets of cross wires, one of which is illuminated. The more distant one is viewed by a powerful Ramsden eyepiece. The virtual image of one set of cross wires serves as an object for the surface tested, and a position is found such that its image in this surface coincides with the image of the other set of cross wires. Tests can be made using objectives of large aperture and immersion lenses with a precision of 0·03 μ. The application of the method for the measurement of radii is discussed, and its freedom from the usual faults of auto-collimation. R. S. R.

1502. Comparative Photographic Tests on Metals for Zeiss Monobromnaphtalin Immersion Objectives and Immersion Objectives of Lower Aperture. C. Benedicks and P. Sederholm. *Arkiv f. Mat. Astron. och Fysik,* 21. 4. *pp.* 1–8, 1928. *In German.*

Tests have shown that the improved sharpness of the photograph expected with the high aperture 1·60 has been obtained, but on account of reflection at the rear surfaces of the objectives a certain dimming and contrast in the picture results. The amount of detail so lost could not be established. No special difficulties occur in mounting the objective. With a magnification of 1600 the objective is to be recommended. For a smaller magnification the aperture 1·40 is sufficient and to be preferred because of its greater freedom from faults and lower cost. For a magnification of 1500 times, an aperture of 1·30 is quite satisfactory. R. S. R.

1503. Optical Axial Angle and Relation of its Plane to Plane of Symmetry in Mica. *Journ. Sci. Instruments,* 5. *pp.* 377–380, *Dec.,* 1928.

After a brief discussion of the optical axial angle of mica a new type of instrument for measuring the angle between the optic axes is described, which is based on the fact that coloured concentric circles cut by a black cross are obtained when mica is viewed between crossed Nicols or in the tourmaline tongs. The instrument consists of two sets of Nicol prisms each with its plane set at 45° to the vertical. In between these is placed a vertical stage carrying the mica samples, which is arranged to rotate in the vertical plane for the correct positioning of the mica, and also horizontally for the obtaining of the angle between the optical axes. Monochromatic light is the most desirable illuminant, but daylight can be used. Tables showing the angle between the optic axes and Shore's hardness figures for various micas are given, it being stated that the optical axial angle of muscovite micas varies between 55° and 75°, that of phlogopite micas between 5° and 25°, and that of biotite micas between 0° and 5°. R. C. F.

1504. Modern Photographic Telescope and New Astronomical Telescope. Part V. New Astronomical Photography. G. W. Ritchey. *Roy. Astron. Soc. Canada, J.* 23. *pp.* 15–36, *Jan.,* 1929.

The author discusses factors determining the size of the image obtained, the visual and photographic resolving powers and their limits for telescopes of given aperture, the methods employed to obtain photographic results more nearly in agreement with the theoretical results, and the conditions affecting the telescope images and the quality of the image on the finished negative. The equipment of a modern astronomical observatory is stated, the use of the instruments, and precautions to be adopted to obtain the best results [see Abstract 2664 (1928)]. R. S. R.

1505. Examination of a Photogrammeter. H. Löschner. *Zeits. f. Instrumentenk.* 48. *pp.* 573–585, *Dec.*, 1928.

Describes tests to which the field photogrammeter should be subjected in order to ascertain the accuracy of the instrument. The first test is an examination of the principal vertical marks, the true vertical being obtained from a long plumb-line which is arranged to extend right across the field of view of the camera. The second test is an examination of the horizontal lines on the photograph, thereby showing whether they are accurately at right angles to the true vertical mark. This is performed on a plate measurer with a hair-line eyepiece. The third test is for parallelism between the mechanical axis of the photogrammeter and the axis of the lateral level. Three methods are given, two of which involve the use of the levelling staff; whilst the third makes use of the vanishing point of two parallel straight lines in space, but this has no great practical use. R. C. F.

1506. Optical Properties of Turbid Solutions of Non-Metallic Particles, and Application of the Pulfrich Diaphragm Photometer. Ursula Milthaler. *Ann. d. Physik*, 1. 2. *pp.* 229–259, *Jan.* 19, 1929.

Discusses the applicability of the Pulfrich instrument [see Abstract 1626 (1925)] to absorption and scattering measurements; describes suitable arrangements for the work; and gives an account of measurements of absorption, scattering and depolarisation in various suspensions. H. R. R.

1507. Polarisation of the Electron Collision Luminosity of the Rare Gases. K. Steiner. *Zeits. f. Physik*, 52. 7–8. *pp.* 516–530, 1928.

Measurements with pure neon gave unambiguous results which are summarised as follows: initial state of the atom corresponding to j_a, the total rotational impulse quantum number, equal to zero—no polarisation observable; $j_a = 1$, $\Delta j = \pm 1$—partial polarisation; $j_a = 1$, $\Delta j = 0$—complete polarisation parallel to the exciting electron stream; $j_a = 2$ or 3, $\Delta j = \pm 1$—complete polarisation parallel to the electron stream; $j_a = 2$ or 3, $\Delta j = 0$—complete polarisation perpendicular to the electron stream. Addition of other gases to the neon in general decreased the polarisation, but in the case of some lines had no effect. A theoretical discussion of the results is included. W. S. S.

1508. Analysis of the Faraday Effect in two Phenomena of Different Origin. Diamagnetic and Paramagnetic Rotation of Polarisation. Laws of Magnetisation for Solid Crystals. J. Becquerel and W. J. de Haas. *Zeits. f. Physik*, 52. 9–10. *pp.* 678–694, 1928.

Earlier work has shown that minerals of the rare earths exhibit a very large power of rotation of paramagnetic origin. The present paper seeks to establish the law connecting the alteration of rotational power as a function of the magnetic field strength. It is evident that at a sufficiently low temperature the rotation would cease to be proportional to the filed strength. At such a temperature, which is reached by means of liquid helium, the phenomenon is actually observed and measured, employing a crystal of tysonite. The use of the latter is justified because it gives the greatest magnetic rotational power, and secondly because it is transparent and can be obtained and used in thick plates. The cryostat used consists of three vacuum glass flasks, the inner one containing boiling helium, the second liquid hydrogen and the third liquid nitrogen. A full description is given of this part of the apparatus. After a description and review of previous work, it is shown that the following equation expresses the law connecting the various factors involved:

$$\rho = \rho_{\infty}\, \mathrm{I}_g \frac{\Sigma_{\infty} \mathrm{H}}{\mathrm{RT}}.$$

The value of Σ_{∞} lies so near to that of the Bohr magneton that it is postulated that the quantity is equal to that of the Bohr magneton. The saturation rotation ρ_{∞} is a function of the wave-length (rotation dispersion), and also the temperature. The intensity of absorption and its relation to temperature is illustrated and measured in the present work. The law is fully valid for the existence of paramagnetic polarisation rotational power, and the form of the equation is in accordance with the theory of Lenz and Ehrenfest on the magnetisation of crystals in the direction of their principal axis. S. G. B.

1509. Optical Rotatory Dispersion of Quartz. T. Bradshaw and G. H. Livens. *Roy. Soc., Proc.* 122. *pp.* 245–250, *Jan.* 1, 1929.

Instead of Lowry's

$$\omega = \frac{7 \cdot 5639}{\lambda^2 - \lambda_1^2} - \frac{2 \cdot 3113}{\lambda^2 - \lambda_2^2} - 0 \cdot 1905,$$

where $\lambda_1^2 = 0 \cdot 0127493$ and $\lambda_2^2 = 0 \cdot 000974$, the authors propose

$$\omega = \frac{845 \cdot 694}{\lambda^2 - \lambda_1^2} - \frac{0 \cdot 40235}{(\lambda^2 - \lambda_1^2)^2} - \frac{838 \cdot 4320}{\lambda^2 - \lambda_2^2} - \frac{0 \cdot 1331233}{(\lambda^2 - \lambda_2^2)^2} + \frac{43 \cdot 05794}{\lambda^2 - \lambda_3^2} + \frac{2119 \cdot 117}{(\lambda^2 - \lambda_3^2)^2}$$

where $\lambda_1^2 = 0 \cdot 0127492$, $\lambda_2^2 = 0 \cdot 01208000$, $\lambda_3^2 = 80$. All the wave-lengths are in microns and the rotations in degrees per millimetre. The influence of the infra-red band is retained, and instead of introducing a new band in the extreme ultra-violet it is only necessary to split the old single band into a close doublet. A. D.

1510. Elliptical Polarisation Produced by Reflection at the Surface of Aqueous Solutions of Fatty Acids. C. Bouhet. *Comptes Rendus*, 188. *pp.* 59–61, *Jan.* 2, 1929.

The ellipticity (E) of fatty acids was measured and the results are shown graphically for different acid concentrations. For acids completely miscible with water, E varies from 0·00040 for pure water to the higher values for the pure acid. The area occupied by each acid molecule at the surface can be found when E is a minimum. The results agree with those of Adam, which conform to Langmuir's hypothesis where molecules of these fatty acids are orientated with the hydrocarbon chain perpendicular to the liquid surface. Examination of the ellipticity-concentration curves indicates that the orientation at the surface of the molecules of the pure acids is very different from that of solutions giving minimum ellipticity. [See Abstract 2865 (1927).] R. S. R.

1511. Polarisation of the Light from Canal Rays. Part III. Mercury Line 2537 from Canal Rays. E. Rupp. *Ann. d. Physik,* 1. 2. *pp.* 289–300, *Jan.* 19, 1929.

Describes the apparatus and methods of measurement employed. The mercury was placed in a small cup inside the discharge tube, and heated by sending a regulated portion of the discharge through it, so that just the correct amount was vaporised. Argon was used in the discharge tube, and in the observing space beyond the canal; the pressure here was kept down to 0·001 mm. Hg, so that the mercury atoms of the canal rays did not collide with other atoms before their light had faded out. With discharge voltages of 15,000, and under, no polarisation was observed, and all measurements of I_p/I_s, the polarisation ratio, were made at 20,000 volts. It was shown that polarisation is only found when disturbances in the emission of the light take place at the slit through which the canal rays pass into the observation space; when the slit was baked out these disturbances ceased, and with them the polarisation of the canal rays. The polarisation ratio was affected by the nature and pressure of the gas employed, and by magnetic fields, in the same way as the resonance fluorescence of the line 2537. The electrical vector of the polarised light is in the direction of the canal ray. If the beam is made diffuse by an obstacle the polarisation disappears. H. N. A.

1512. Theory of Diffusion of Light by a Body Placed in an Electric or Magnetic Field. Y. Rocard. *Ann. de Physique,* 10. *pp.* 472–488, *Nov.–Dec.,* 1928.

Discusses theoretically how the intensity and state of polarisation of the light diffused by a body would be modified if it were placed in a field which orientated its molecules. The molecules are either supposed to be anisotropic and polarisable from the optical, electric or magnetic point of view, or to have permanent electric or magnetic moments. Optical anisotropy is always necessary, since without this all effects due to the orientation disappears. The result of the discussion shows that the effect must always be very small, so that it can hardly be expected to be observable at ordinary temperatures. At very low temperatures this should not be the case, and experiments here, besides their optical interest, should show in a direct manner how the theory of quanta is concerned in statistical problems of molecular orientation. H. N. A.

1513. Raman Diffusion. A. Carrelli. *Accad. Lincei, Atti,* 8. *pp.* 155–160, *Aug.,* 1928.

The Raman effect may be considered as a diffused radiation foreseen by the quantistic theory of diffusion; and the Raman light ought to be much fainter than the ordinary The number of rays to be observed depends on the number of characteristic frequencies of the monad in the infra-red; but in the diffused light there ought also to be found frequencies greater than that of the exciting light, whose intensity is less than that of the frequencies which follow Stokes' law. A. D.

1514. Scattering of Light in Colloidal Solutions and Gels. Part I. Agar Sol and Gel. K. Krishnamurti. *Roy. Soc., Proc.* 122. *pp.* 76–103, *Jan.* 1, 1929.

Investigates the effect of temperature on the intensity and depolarisation of the scattered light. Regards agar sols as colloidal solutions with a molecularly dispersed solution of agar as the intermicellary liquid. When the temperature is lowered to about 35° the dispersed solution becomes supersaturated, and tends to precipitate; it is probable that at first fresh colloidal particles are formed, but in the end agar is deposited on the particles already present, altering their form and so affecting the polarisation of the scattered light. Each of these micelles is surrounded by a hydration layer, and their final union with one another forms the gel. All this is deduced from the measurements of the scattered light made during the cooling and the formation of the gel. The effect of concentration of the agar was also studied. The existing theories of gel formation are considered. It is suggested that the process may not take place in exactly the same way for all substances. H. N. A.

1515. Optical Properties of Liquid Films in Newton's Dark Space. S. Chella. *N. Cimento*, 5. *pp.* 416–431, *Dec.*, 1928.

The liquid films in Newton's dark space have very different properties from those of the rest of the liquid. The dispersion is notably greater than that of water or any other liquid. There is an absorption band near 2300 Å, which cannot be explained by the absorption of water or oleic acid. The thickness of these films cannot exceed 5×10^{-7} cm., and is perhaps much smaller [see Abstract 1347 (1906)]. E. E. F. d'A.

1516. Device for the Simultaneous Photography of Three Selected Images. C. Nachet. *Comptes Rendus*, 187. *pp.* 1172–1174, *Dec.* 10, 1928.

The use of a system of reflectors for the simultaneous registering of three separate images for colour photography results in a loss of light, with a consequent increase in time of exposure. If three independent lenses are used, a stereoscopic effect results, with consequent lack of sharpness in the final superposition of the three monochromes. The instrument described by the present author is based on the fact that for a sharp final image the rose and blue-green monochromes must be perfectly sharp, whilst the yellow monochrome can be somewhat diffuse. This also holds when considering the geometric identity of the yellow and the other two images. Three similar objectives are used, and the images from these three are photographed side by side on a plate or film. One objective photographs directly, whilst for the other two the optical axes are virtually brought into coincidence by the use of two reflecting mirrors at 45°. Owing to the short focal length, the view-points of the two latter objectives can be considered identical, whilst only a small stereoscopic effect can be observed for near objects between the image formed by the direct viewing lens and those from the other two objectives. Complimentary colour screens are placed just after the lenses to give the necessary images for colour photography. R. C. F.

1517. Development after Fixation of Inversed or Solarised Photographic Plates. H. Belliot. *Comptes Rendus*, 187. *pp.* 1289–1292, *Dec.* 26, 1928.

The author's hypotheses, based on Perrin's general photochemical theory for the formation and destruction of the photographic latent image, are first briefly given. An attempt is made experimentally to prove these hypotheses, it being shown that the theory is not quite correct, as certain results are found to be between those given by chemical development and results suggested by the theory. R. C. F.

1518. Anti-Fogging and Anti-Sensitising Effects. S. E. Sheppard. *Kodak Research Lab. Comm. No.* 342. *Phot. J.* 69. *pp.* 37–40; *Disc.*, 40–42, *Jan.*, 1929.

Suggests a definite chemical mechanism of nucleus inactivation for the action of thioanilides on the basis of the greater reactivity of the silver halide at the interface of sensitising nuclei and silver halide. The theory is also extended to the photographic activity of iminazoles and dye desensitisers. In the *Discussion*, **Florence Hamer** referred to statements regarding compounds containing a $>C = N -$ group, and said that many desensitisers lacked such a group, whilst a number of the compounds possessing the group were either sensitisers or photographically inactive. **T. Slater Price** queried the author's method of use of Lecher's formulation of the thiocarbamides and analogous compounds, stating that the formulation is difficult to bring into line with modern ideas. He suggests a satisfactory meaning which can be given to the formulation. R. C. F.

1519. Inner Photo Effects in Silver Haloids and the Spectrum. E. A. Kirillow. *Zeits. f. Wiss. Phot.* 26. *pp.* 235–248, *Jan.*, 1929.

The increase in conductivity of granular layers of AgI, AgBr, AgCl, when exposed to light was investigated by means of the exposure of the salts to different parts of the spectrum. The changes of conductivity were measured by a compensation method, employing a valve and filament galvanometer. It was shown that after illumination with photographically active light, new maxima were evident in the long wave-length portions of the spectrum. AgBr, and to a lesser degree AgCl, showed a decrease in electrical conductivity when exposed to the action of light. F. J. B.

1520. Herschel Effect. Lüppo-Cramer. *Zeits. f. Wiss. Phot.* 26. *pp.* 249–259, *Jan.*, 1929.

As a result of further work on this subject, the present author corrects his previous statement regarding the fact that the Herschel effect can occur when blue light is used [see Abstract 2686 (1928)]. The effects previously observed are shown to be due to red and infra-red radiations which are transmitted by filters purported to absorb them. Previous work on diffusely illuminated diapositive plates impregnated with certain green desensitising dyes has shown that a remarkable increase in sensitivity to red light is obtained. The present author shows, from results obtained on plates impregnated with various other desensitising dyes, that certain blue and red dyes also produce a similar effect, and that it should not be considered due to green dyes only. Finally, a brief historical survey and discussion of the analogy of the Herschel effect and phosphoresence phenomena, largely emphasised at the present time, is given. R. C. F.

1521. Low Wave-Length Boundary of the Herschel Effect. E. Mauz. *Zeits. f. Wiss. Phot.* 26. *pp.* 289–294, *Feb.*, 1929.

After a brief discussion of Lüppo-Cramer's results [see Abstract 2686 (1928) and preceding Abstract], the present author shows that the Herschel effect for " Satrox " paper, with which Lüppo-Cramer mainly worked, has a low wave-length limit of approximately 6000 Å. This limit is slightly variable, dependent on the time of illumination before exposure, being 5800 Å. with a previous illumination of ½ min. and 6100 Å. with 32 min. Plates coated with the same emulsion as the " Satrox " paper showed the same low wave-length limit for the Herschel effect. R. C. F.

1522. Halogen Silver Photochemistry. Part IV. New Method for Estimating the Surplus Silver in Unilluminated Layers, and Phenomena of the Illumination Process. H. H. Schmidt and F. Pretschner. *Zeits. f. Wiss. Phot.* 26. *pp.* 259–274, *Jan.*, 1929.

Describes a new method, consisting of centrifuging the unilluminated layers in neutral solutions, which gives similar values for the surplus silver to those obtained for the authors' gravimetric method by destruction with nitric acid [see Abstract 2685 (1928)]. The method also has the advantage of being suitable for work on illuminated layers. The "silver value" obtained from the centrifuging process, when treated with dichromate sulphuric acid, is found to consist of three parts. The first and largest part, which is highly distributed throughout the gelatine, and is contained in the liquid discharged from the centrifuge, is dissolved by the acid, as is the second part, which is adsorbed by the grain. This dissolving occurs, in both cases, without alteration of the photographic properties of the layer. The third part, also adsorbed by the grain, is not dissolved, and since treatment by dichromate sulphuric acid does not affect the sensitivity of the silver chloride emulsion, it appears that this last part does not appreciably influence the sensitivity. In the illumination process of the silver chloride emulsion, as with gelatine-free silver chloride, the halogen part of the grain comes away from the remainder and can be washed out with water. The illuminated silver, however, is firmly held by the grain, and is not completely dissolved by destruction with nitric acid and treatment with dichromate sulphuric acid. Smaller "silver values" were obtained for the silver chloride emulsions containing only a small quantity of gelatine than those given previously for similar emulsions richer in gelatine. The authors again conclude that there is no direct connection between the "silver value" and sensitivity, but further work is still to be done, especially on the estimation of the standard components of the "silver value" free from objection. R. C. F.

1523. Intermediary Regression. Lüppo-Cramer. *Zeits. f. Wiss. Phot.* 26. *pp.* 285–299, *Feb.*, 1929.

Shows by means of photographs and densograms that solarisation is definitely prevented by the impregnation of the plates with bromide acceptors. The example given is for a plate impregnated with sodium nitrate [see Abstract 1902 (1928)]. Further, no change in effect is produced in the part of the impregnated plate illuminated by red light, when compared with the similar part on a non-impregnated plate, and although this is not a normal Herschel effect, owing to the plate not being illuminated before exposure, yet it is sufficient to show the indifference of the Herschel effect to bromide acceptors. This intermediate Herschel effect, as it can be termed, is due to protective action of the red radiation, already observed by previous authors. A brief discussion of this intermediate reversal, considering results obtained by other authors, is given.

R. C. F.

1524. Dyes in Photographic Reduction and Oxidation Processes. A. Steigmann. *Zeits. f. Wiss. Phot.* 26. *pp.* 299–304, *Feb.*, 1929.

Reviews the present state of knowledge of the action of dyes in the photographic reduction and oxidation processes, in view of the fact that the study of the bleaching of photographic emulsions is directly connected with the study of photographic sensitivity. R. C. F.

1525. Ripening Nuclear Silver. H. Kieser. *Zeits. f. Wiss. Phot.* 26. *pp.* 305–310, *Feb.*, 1929. *Zeits. f. Elektrochem.* 35. *pp.* 51–53, *Jan.*, 1929.

Criticism of proposed methods of determining the ripening nuclear silver in photographic emulsions. A. D.

1526. Sensitivity of Photographic Emulsions. Part III. Magnitude of Variation of Sensitivity with Change of Hydrogen-Ion Concentration. S. O. Rawling. *British Phot. Research Assoc. Lab. Comm. No.* 70. *Phot. J.* 69. *pp.* 83–93, *Feb.*, 1929.

Shows that the relative change in sensitivity, for photographic emulsions made with four different gelatines, which occurs rapidly on making a change of *p*H from one given value to another during digestion after washing, was a characteristic of the gelatine. It was independent of whether the grains were pure silver bromide or bromide with 4 % silver iodide, or of whether or not ammonia ripening before washing had been used. Not only was there the rapid and almost fully reversible effect of *p*H variation, but, in addition, evidence was also found supporting a slow change in sensitivity which occurred at the same time, and was dependent on the *p*H of the emulsions during digestion. Generally the sensitivity increased more rapidly during digestion at high *p*H than at low. The *p*H values used throughout the experiments were 8·5 and 5·0 during digestion, and 7·5 and 5·0 at coating, and at these values certain examples were found in which the fog shape of the characteristic curve and the rate of development were independent of *p*H during digestion. Sensitisation with thiosinamine before washing was found in one case to make no difference to the magnitude of the rapid *p*H-sensitivity effect. [See also Abstracts 988 and 1347 (1927).] R. C. F.

1527. Ultra-Violet Spectrophotometry. H. J. McNicholas. *Bureau of Standards, Journ. of Research* 1. *pp.* 939–949, *Dec.*, 1928.

The paper describes a device for the operation of a high-voltage electric discharge between metal terminals under distilled water and its use with the Hilger sector photometer in ultra-violet spectrophotometry. The spark terminals are enclosed in a hard-rubber box through which a stream of distilled water may be circulated. External adjustments are provided for the length of the spark gap and its position relative to the axis of the optical system. The effect of the dispersion introduced by the biprism and wedges of the sector photometer is discussed in its relation to the adjustment of the spark; and some modifications in the construction of the photometer are suggested. AUTHOR.

1528. Fluorescence Excited in Oxygen and Nitrogen by Ultra-Violet Light of Short Wave-Length. J. C. McLennan, R. Ruedy and F. H. Clements. *Roy. Soc. Canada, Trans.* 22. *Sect.* 3. *pp.* 253–255, *May*, 1928.

Light in the region of 1100 Å. was produced by Lyman's method [see Abstract 2844 (1926)]. The fluorescent light was photographed with a small quartz and with a glass spectrograph. The first negative and the second positive bands of nitrogen were excited; also a number of atomic oxygen lines, the Balmer series and a line or band about λ4780 Å. observed by Oldenberg [see Abstract 681 (1927)]. The auroral green line did not appear, probably due to the high gas pressure. A method of exciting this line by itself is suggested. F. S.

1529. Intensities of Light of Oxygen Green Line of Night Sky. J. C. McLennan, J. H. McLeod and H. J. C. Ireton. *Roy. Soc. Canada, Trans.* 22, *Sect.* 3. *pp.* 397–412, *May*, 1928.

Measurements on the intensity of the oxygen green line radiation from the night sky in Arizona and in Toronto showed that while the intensity of this light after sunset showed numerous small and unexplained fluctuations, it gradually increased to a maximum value about an hour after midnight, and then fell off with lapse of time to sunrise. Possible explanations of the results are discussed. W. H. GE.

1530. Theory of Sensitised Fluorescence. A. Carrelli. *Accad. Lincei, Atti*, 8. *pp.* 495–500, *Nov.* 18, 1928. *Zeits. f. Physik*, 53. 3–4. *pp.* 210–215, 1929.

A mathematical paper in which the phenomenon of sensitised fluorescence is treated on the basis of wave mechanics by the method used by Born in elaborating the theory of the inelastic shock between the electron and the material atom. T. H. P.

1531. Fluorescence of Benzene and its Infra-Red Absorption. V. Posejpal. *Comptes Rendus*, 187. *pp.* 1046–1048, *Dec.* 3, 1928.

The fluorescent spectrum of benzene is given for two series, and the mean frequencies and wave-lengths of these series are also given. The values agree well with those observed by Puccianti and Coblentz, and calculated by V. Henri. Other bands not in these groups result from other infra-red absorption bands; examples of these are included, and agree well with experience. Further, the fluorescent spectrum of benzene gives the same absorption bands in the infra-red as the Raman spectra.
R. S. R.

1532. Permanent Luminescence of Certain Crystallised Uranium Salts. R. Coustal. *Comptes Rendus*, 187. *pp.* 1139–1140, *Dec.* 10, 1928.

The luminosity of the uranium salts is visible only if the eye is made sensitive by being in a darkened room for 30 min. or more. The luminosity is independent of previous insolation, of time and of temperature, while infra-red light has no effect on it. It is greatest for the sulphate, less for the nitrate, less again for the acetate, and for others too feeble to be observed. Calculations show that the energy of the α-particles is more than sufficient to account for the luminosity. R. S. R.

1533. Relation between Luminosity and Concentration in Luminescent Solid Solutions. J. Ewles. *Leeds Philosoph. and Lit. Soc., Proc.* 1. *pp.* 341–345, *Jan.*, 1929.

Criticises the theory of Merritt, and assumes that the luminescent centre responsible for a given band consists of an absorbing atom B associated with a large and definite number n of atoms A of the non-luminescent solvent. Works out an expression for the probability of such a group being formed with a random distribution, and obtains an expression for the relation between the concentration and the brightness which is exactly similar to the equation of Bruninghaus for kathodoluminescence. Tests were made with solid solutions of bismuth in calcium oxide of different concentrations. The observed brightness was plotted against the concentration; conditions were kept constant for all the samples. The curve obtained has two maxima, and this is interpreted as implying the existence of two kinds of active centre, in the first of which a Bi atom is associated with 5012 CaO molecules, which implies that the range of action of the active bismuth atom extends in this centre across about eleven unit cells each way; in the second group of centres a bismuth atom is associated with 331 CaO molecules, and the range of action is four or five unit cells each way. H. N. A.

1534. Vectorial Treatment of Luminous Vibrations. F. Odone. *Accad. Sci. Torino, Atti*, 63. *4a–6a. pp.* 71–81, 1927–1928.

Shows that vectorials permit notable simplifications in the treatment of the properties of luminous vibrations. Applications to the analytical expression of a vibration, to ellipticity, to the orientation of an elliptic vibration, to elliptical double refraction and to the intensity of a vibration. A. D.

1535. Spectral Intensities of Radiation from Non-Harmonic and Aperiodic Systems. B. Cassen. *Nat. Acad. Sci., Proc.* 14. *pp.* 880–882, *Nov.*, 1928.

Matrix methods are employed to derive the matrix components of the acceleration in a given coordinate in a system governed by quantum mechanics. The result is used to obtain the radiation emitted by a uniformly accelerated electron and an electron bound to a positive nucleus. W. S. S.

1536. Optical Resonance in Undulatory Mechanics. E. Persico. *Accad. Lincei, Atti*, 8. *pp.* 160–163, *Aug.*, 1928.

The resonance light is polarised like the incident light, and its intensity is proportional to the intensity of the latter. The natural breadth of the resonance ray, when the incident light presents a ray of appreciable breadth, is about 5/3 that of the ray of spontaneous emission. [See Abstract 1061 (1929).] A. D.

1537. Angular Distribution of Intensity of Resonance Radiation. R. W. Gurney. *Nat. Acad. Sci., Proc.* 14. *pp.* 946–951, *Dec.*, 1928.

Doubts the existence of random emission. Indirect evidence shows clearly that there is a variation with angle and even its magnitude. E. E. F. d'A.

1538. Absorption in Excited Helium. J. C. McLennan, R. Ruedy and Elizabeth Allin. *Roy. Soc. Canada, Trans.* 22. *Sect.* 3. *pp.* 273–277, *May*, 1928.

Light from a discharge tube was focussed through an absorption tube on to the slit of a spectrograph. Both tubes were excited by direct current generators. The density of the observed lines was measured with a Moll microphotometer. The absorption observed is a lower limit necessary to produce distinct reversals with an echelon. The absorption of the various lines is found to be similar to the decrease of intensity of the Balmer series according to Schroedinger's theory. F. S.

1539. Investigation of the Helium Bands. Y. Fujioka. *Zeits. f. Physik*, 52. 9–10. *pp.* 657–667, 1928.

An experimental investigation of the relative intensities of the Helium bands obtained by excitation with direct current and also with condenser discharge. In the course of the experiments it is shown that in addition to the band found by Merton and Pillay at $\lambda = 535$ there is also another band of similar structure whose intensity is very much enhanced in the direct current discharge at $\lambda = 495$. The second part of the paper consists of an analysis and comparison of these bands. S. G. B.

1540. Nitrogen Afterglow. J. C. McLennan, R. Ruedy and J. M. Anderson. *Roy. Soc. Canada, Trans.* 22. *Sect.* 3. *pp.* 303–320, *May,* 1928.

A special discharge tube with tungsten electrodes was excited by an oscillating discharge. A specially constructed direct vision spectrograph was used from 9600 Å. to 3200 Å. Xenon was found not to be excited, although the necessary energy is less than for metallic vapours. Effects such as rate of decay at different pressures cannot be explained by a simple transfer of energy. The effect of inert gases seems to be due to pressure alone, and is not selective. The bands observed can be accounted for by the theory of intensity distribution in a band system, and is here applied to the first positive bands. F. S.

1541. Spectra Excited by Active Nitrogen. J. H. Findlay. *Roy. Soc. Canada, Trans.* 22. *Sect.* 3. *pp.* 341–352, *May,* 1928.

Describes experiments carried out with a view to obtaining a clearer insight into the nature of active nitrogen, its energy content and the mechanism by means of which it excites the spectra of vapours. From a comparison of the spectra of the exciting electrodeless discharge when the afterglow was and was not present, it was shown that the main differences observed were a more intense spectrum with afterglow, and the presence of the first positive nitrogen bands in the discharge which produced no afterglow and absence when afterglow was observed. It was not found possible to excite the resonance spark lines of calcium, although lines of sodium and potassium, probably impurities in the calcium, were present in the afterglow. The spectrum of mercury excited by active nitrogen showed that the highest energy level to which the mercury atom could be excited in this way was the 4^3D level, which corresponds to an excitation potential of 9·51 volts. From measurements of the mercury-vapour pressure when the blue glow is produced it was shown that chemiluminescence was not precluded from being a possibility of the origin of spectra excited by active nitrogen. The temperature at which the blue glow appeared was found to be 130° C. Indium does not appear to combine with nitrogen, as all efforts to excite the indium spectrum by active nitrogen were unsuccessful. R. C. F.

1542. Raman Effect with Liquid Oxygen and Nitrogen. J. C. McLennan and J. H. McLeod. *Roy. Soc. Canada, Trans.* 22. *Sect.* 3. *pp.* 413–417, *May,* 1928.

Three Raman lines have been observed for each liquid. Two in each case agree with the vibration frequency calculated from band spectra. It would seem that the other line in each case corresponds to the second vibration state of the element. It is suggested that nonpolar molecules, as well as those having well-defined electric moments, may be capable of investigation. F. S.

1543. Production of New Radiations by Light Scattering. Part I. C. V. Raman and K. S. Krishnan. *Roy. Soc., Proc.* 122. *pp.* 23–35, *Jan.* 1, 1929.

When monochromatic light is scattered in any transparent medium the radiations scattered by the molecules contain lines whose frequencies differ from that of the incident radiation by an amount corresponding to a characteristic infra-red frequency of the molecule [see Abstracts 2368

(1928) and 134 (1929)]. In the present paper the scattered spectra of benzene, toluene and carbon tetrachloride have been photographed and measured. Calculations of the characteristic infra-red frequencies are compared with those given by direct measurement, and several new molecular frequencies are discovered. Some of the modified lines are found to exceed the frequency of the exciting line, thus giving for the first time an experimental proof of induced emission or negative absorption. The modified radiations scattered at 90° exhibit polarisation. Tentative explanations of the observed phenomena are given. T. B.

1544. Breadth of the Spectral Lines of Raman's Scattered Radiation from Benzole. W. Gerlach. *Ann. d. Physik*, **1. 2.** *pp.* **301–308,** *Jan.* **19, 1929.**

The spectrum has been photographed, using a mercury lamp; for purposes of comparison the spectra of the same light diffused from white paper and by sal ammoniac mist were photographed on the same plate. The broadening of the Raman lines and that of the Hg lines are easily seen in the case of benzole. The lines were measured with a Rosenberg photometer, and curves are given showing the intensity distribution for all the benzole lines. The Raman lines are all diffuse and unsymmetrical, the broadening being greater on the long wave-length side. The mercury lines, which show the effect of scattering without *large* frequency change, are much broadened on both sides, but more on the long wave-length side. The phenomena are discussed theoretically, and their relation to the infra-red band of benzole is considered. H. N. A.

1545. Intensity Measurements in the Secondary Spectrum of Hydrogen. W. Kapuscinski and (Miss) J. G. Eymers. *Roy. Soc., Proc.* **122.** *pp.* **58–68,** *Jan.* **1, 1929.**

Intensity measurements of a part (4500–4900 Å.) of the secondary spectrum of hydrogen have already been given by Ornstein and the present authors [see Abstract 2375 (1928)]. These results are now extended to other parts of the spectrum (3652 Å.–6442 Å.), the number of separate measurements being no less than 1427. The experimental methods are similar to those employed in the former investigation, but in order to get a greater intensity of light a tube of the "end-on" type was used. Lines 0·2 Å. apart were distinctly separated, the whole spectrum being taken at a pressure of hydrogen of about 0·17 mm. and a current of 28–35 mA. A theoretical discussion is promised in a later paper. T. B.

1546. Light from Hydrogen Canal Rays. B. Dasannacharya. *Ann. d. Physik*, **1. 1,** *pp.* **74–92,** *Jan.* **2, 1929.**

Gives a simple derivation for Wien's formula for the intensity of the hydrogen, canal ray, Balmer spectrum and a correction factor for a formula in a previous work by the author. The value of σ, the energy radiated per second in the H_α line by a neutral atom, has been measured and compared with those previously obtained for H_β and H_γ; the respective values are 21·85, 0·878 and $0 \cdot 196 \times 10^{-7}$ erg/sec. Proposes the following empirical formula for the total disturbance of light: $c^0 v_d (h\nu)^3 = C^0$, where C^0 a constant is equal to $0 \cdot 994 \times 10^{-25}$; $h\nu$ is the energy quantum, c^0 the total disturbance and v_d the velocity of the canal ray. An empirical formula for the excitation of light is also proposed, and the combination of the two formulæ gives a formula for the radiation of light energy in $h\nu$/sec. per atom. The formulæ are represented graphically. H. N. A.

1547. Experimental Investigation of Negative Dispersion. H. Kopfermann and R. Ladenburg. *Zeits. f. phys. Chem.* 139. *pp.* 375–385, *Dec.*, 1928.

When the current density is increased in the positive column of a neon discharge up to 0·1 ampere per sq. cm. an enhancement of the anomalous dispersion is observed of the orange *s–p* lines, involving therefore an increase in the excited atoms in the *s*-states. But if the current density is still further increased a general falling off in the anomalous dispersion (in the N-values) of the $s_5–p_K$ lines is remarked. This is what would be expected on the quantum-theoretical dispersion formula on account of the influence of the " negative " dispersion, *i.e.*, because of the greater excitation of the atoms in the p_K states. A. C. M.

1548. Characteristic Differentiation in the Spectra of Saturated Hydrocarbons. F. S. Brackett. *Nat. Acad. Sci., Proc.* 14. *pp.* 857–864, *Nov.*, 1928.

The great moment of inertia of polyatomic molecules precludes the resolution of the rotation spectrum, but information about the binding forces may be got by investigation of the vibration spectrum in the near infra-red, although dimensional data cannot be got directly in this way. An attempt is here made to associate certain vibration frequencies in the spectra of saturated hydrocarbons with the different hydrogens so that heats of dissociation of the various hydrogens may be investigated. The relative binding forces exerted upon the hydrogens when attached to the primary, secondary and tertiary carbons are dealt with. A very small upper limit has been placed upon the possible difference in binding of the different hydrogens in benzene, and it is pointed out that the binding force in benzene is considerably greater than in the saturated hydrocarbons. A. C. M.

1549. Origin of the Continuous Spectrum of the Hydrogen Molecule. J. G. Winans and E. C. G. Stueckelberg. *Nat. Acad. Sci., Proc.* 14. *pp.* 867–871, *Nov.*, 1928.

Heitler and London have shown by the application of wave mechanics that as well as the state 1^1S, another state exists which they call 1^3S, which represents another way in which two H atoms may react with one another. It is here suggested that the transition from any one of the excited triplet levels to the ground state of this system (1^3S) must give a continuous spectrum extending from the extreme ultra-violet into the visible. This idea is developed by wave mechanics, and it is shown that deductions fit the experimental facts. A. C. M.

1550. Critical Potentials of Molecular Hydrogen. E. U. Condon and H. D. Smyth. *Nat. Acad. Sci., Proc.* 14. *pp.* 871–875, *Nov.*, 1928.

A summary of the results is given of a number of experiments by different observers in recent years on the impact of electrons with hydrogen molecules, and apparent inconsistencies are pointed out. It is believed that these are capable of interpretation by considerations similar to those put forward by Winans and Stueckelberg [see preceding Abstract], and the argument is developed in general terms. A. C. M.

1551. Multiplets of Ionised Lead, PbIII. S. Smith. *Nat. Acad. Sci., Proc.* 14. *pp.* 878–879, *Nov.*, 1928.

PbIII should have triplet and singlet terms, like HgI. Here triplet terms only are considered, and $P-\bar{P}$, $P-D$, $P-S$ and $D-F$ multiplets are identified. A. C. M.

1552. Optical Behaviour of Hydrogen Atoms in Very Strong Electric Fields. R. v. Traubenberg. *Phys. Zeits.* 29. *p.* 894, *Dec.* 1, 1928. *Paper read before the Deut. Naturforscher u. Ärzte, Hamburg, Sept.*, 1928.

Fields up to 420,000 volts/cm. have been employed and Stark effects of both first and second order observed. Measurements made on H_γ agree better with the theory of Schrödinger than with that of Epstein. The work on hyperfine structure of hydrogen lines is to be continued.

F. S.

1553. Times of Light Emission. J. Stark. *Ann. d. Physik*, 1. 3. *pp.* 323–340, *Feb.* 9, 1929.

This is a continuation of previous work [see Abstract 1174 (1929)]. It is pointed out that while R. v. Traubenberg's value for the time of emission of $H\gamma$ is 10^{-9}, the value calculated by the author was 5×10^{-13} sec. Experimental work with a large prism and grating spectrograph was undertaken to investigate the light emitted by hydrogen canal rays. The sources of error are fully discussed. It is concluded that the effect of the electric field on the lines $H\alpha$, $H\beta$ and $H\gamma$ of which the emitters are moving with a velocity of about 7×10^{7} cm. per sec. is to move the line less than $0 \cdot 1$ mm. forward. As a consequence, the time of emission cannot be less than 10^{-10} sec. The significance of earlier observations on the time of emission by canal rays is then discussed.

F. S.

1554. Mode of Action of the Electro-Optical Shutter of J. W. Beams and Significance of Certain Researches Employing the Shutter. L. v. Hámos. *Zeits. f. Physik*, 52. 7–8. *pp.* 549–554, 1928.

Beams' electro-optical shutter [see Abstract 1020 (1927)] is criticised on the ground that the light intensity at the instant of opening is not uniform as claimed, and hence the " open period " is not definable except in some more or less arbitrary fashion. Conclusions drawn by Beams and collaborators in certain researches using the shutter [see Abstracts 2486 and 2868 (1927)] are rejected. In particular, the possibility of determining from Beams' measurements a lower limit to the length of a train of waves, capable of producing photoelectric action, is denied. W. S. S.

1555. Band Spectra of CO. G. Herzberg. *Zeits. f. Physik*, 52. 11–12. *pp.* 815–845, 1929.

Previous work on the band spectra of nitrogen [see Abstracts 3024 and 3230 (1928)] is now continued. A new band system of CO has been found in the electrodeless ring discharge which has the same end state as the Ångström bands. The initial state is a D-state. The behaviour of these bands and the other band systems of CO in the electrodeless discharge is now described, and a series of observations with respect to the intensity distribution in these band systems is recorded, these being in close analogy with the behaviour of N_2. Dissociation procedure for CO^+ and CN are also treated, as these are very similar to N_2^+. An Appendix describes the behaviour of the Swan$^-$ and CN$^-$ bands in the electrodeless discharge, the occurrence of special single band lines being discussed. Comprehensive tables of data are included. H. H. Ho.

1556. Infra-Red Emission Spectra of the Bunsen and Allied Flames. C. R. Bailey and K.-H. Lih. *Faraday Soc., Trans.* 25. *pp.* 29–32, *Jan.*, 1929.

The emission spectra in the infra-red of the Bunsen and Meker flames were re-examined. Revised values for the maxima were obtained and the conditions for constancy were determined. The intensity ratios of the bands at 2·8 and 4·5 μ were shown to vary greatly from flame to flame. The spectra from mixtures of carbon monoxide and hydrogen were also obtained and recorded. F. J. B.

1557. Infra-Red Emission Spectra of the Separated Cones in Methane and Bunsen Flames. C. R. Bailey and K.-H. Lih. *Faraday Soc., Trans.* 25. *pp.* 32–36, *Jan.*, 1929.

An examination of the infra-red emission spectra of the separated cones of the methane and coal-gas flames was carried out. The results are given in the form of curves and a table of maxima is included. No trace was found of emission from the new-formed molecules of carbon monoxide in the inner cone, and the water vapour spectrum is much more prominent than in the outer cone. A band at 3·35 in the methane spectra is attributed to thermal emission from heated methane. F. J. B.

1558. Vacuum Spark Spectrum of Lead from 2200 Å. to 5000 Å. S. Smith. *Roy. Soc. Canada, Trans.* 22. *Sect.* 3. *pp.* 331–335, *May*, 1928.

Wave-length measurements on the vacuum spark spectrum of lead were made on plates taken with a concave grating. These extend the measurements made by Carroll and should be of use in determining the structure of the spectra of PbIII and PbIV. A table is given of all the lines measured between 2200 Å. and 5000 Å. containing values for the wave-lengths in international Ångström units in air, the intensities and the wave numbers. R. C. F.

1559. First Spark Spectrum of Thallium, TlII. J. C. McLennan, A. B. McLay and M. F. Crawford. *Roy. Soc. Canada, Trans.* 22. *Sect.* 3. *pp.* 241–245, *May*, 1928.

The lines due to TlII in a thallium spark were distinguished by inserting self-induction in the circuit. The spectrum was photographed with a small quartz and a fluorite spectrograph. Nineteen lines attributed to TlII are listed and classified, and several of the classifications are discussed. F. S.

1560. Multiplets of Singly Ionised Thallium. S. Smith. *Nat. Acad. Sci., Proc.* 14. *pp.* 951–953, *Dec.*, 1928.

By interpolating between the data for HgI and PbIII, a number of multiplets of TlII have been found in the data of Carroll [see Abstract 1354 (1926)] and some unpublished ones of Lang. Tables of these and of lines which have been classified are given, the latter included some lines measured by a 2-metre concave grating on a Rowland mounting in air. An ionisation potential of 21·4 volts is calculated. F. S.

1561. Second Spark Spectrum of Mercury, HgIII. J. C. McLennan, A. B. McLay and M. F. Crawford. *Roy. Soc. Canada, Trans.* 22. *Sect.* 3. *pp.* 247–251, *May*, 1928.

The spectrum of the mercury spark in hydrogen in the range λ1935 Å. to λ1350 Å. has been investigated with a fluorite spectrograph. An alternating discharge in mercury vapour has also been used with a 1-metre vacuum grating instrument, but Carroll's wave-lengths below λ1350 Å. have been adopted [see Abstract 1354 (1926)]. The lines which have been classified are listed, and comparison made with the similar spectra, PtI and AuII. F. S.

1562. Conversion of Excited 2^3P_1 Mercury Atoms into the Metastable State 2^3P_0. H. Klumb and P. Pringsheim. *Zeits. f. Physik*, 52. 9–10. *pp*. 610–626, 1928.

The concentration of the atoms in the metastable state 2^3P_0 was determined from the absorption of the line 4047 Å. ($2^3P_0 \rightarrow 2^3S_1$). This was measured for different pressures of the added gases (He-Ne, Ar, N_2, CO, CO_2, H_2O) for different pressures of gaseous impurities, and as a function of the intensity of the transverse illumination by means of which a proportion of the Hg atoms in the absorption tube were raised to the 2^3P_1 state. Simple theory indicates that the number of atoms in the 2^3P_0 state should be independent of the pressure of the added gas. This is not in accord with experiment (especially at low pressures of the added gas) and other factors, presence of impurities, collisions with the walls, etc., must be taken into account. By doing this, a satisfactory explanation of the experimental results is obtained. The particularly large absorption produced by nitrogen is attributed in part to a broadening of the absorption line as result of a resonance effect. W. S. S.

1563. Voltage-Intensity Relations of the Mercury Spectrum. P. B. Taylor. *Frank. Inst., J*. 207. *pp*. 95–106, *Jan*., 1929.

The photographic method used by Valasek [see Abstract 2718 (1927)] was used to investigate the 29 most prominent lines between 2378 and 4108, with the exception of 2537 which is complicated by absorption. Photographs were taken with a quartz spectrograph with various voltages applied to the mercury arc, and the densities measured with a densitometer. The results are expressed by tables and curves. F. S.

1564. Zeeman Effect and Arrangement of Terms in the Spectrum of Singly Ionised Chromium. E. Krömer. *Zeits. f. Physik*, 52. 7–8. *pp*. 531–548, 1928.

The Zeeman effects of 50 Cr^+ lines give the magnetic splitting factors of the terms so far known and in addition of two further term multiplets. This complete term system agrees with the theoretical one. It is also possible to determine definitely the electronic configuration for each term multiplet. Intercombinations exist between the terms resulting from different electronic configurations. A number of tables embody the results obtained. H. N. A.

1565. Band Spectra Associated with Zinc, Cadmium and Mercury. J. M. Walter and S. Barratt. *Roy. Soc., Proc*. 122. *pp*. 201–210, *Jan*. 1, 1929.

From a detailed examination of the band spectra associated with the metals in group IIb of the periodic table, it is shown that most of the absorption bands previously ascribed to zinc and cadmium, and one band system previously attributed to mercury, are not metallic band spectra but appear to be oxide and chloride spectra. Only one weak and diffuse band was found for each of zinc and cadmium, whilst the absorption spectrum of mercury was found to contain several such bands due to the metal. This is direct proof that mercury vapour contains diatomic molecules. Further, absorption band systems, which were analogous to those of the chlorides of the metals, were obtained for the bromides as well as for calcium iodide. R. C. F.

1566. Band Spectrum of Beryllium Oxide. E. Bengtsson. *Arkiv f. Mat. Astrom. och Fysik, Stockholm*, 20. 28. *pp.* 1–18, 1928. *In German.*

The spectrum of beryllium oxide introduced into a carbon arc was photographed with a 6-m. concave grating and with a quartz spectrograph. Particulars of six bands in the visible which have been analysed are given. Each band has been resolved into P and R branches. The rotation and dissociation energies, as well as the moment of inertia of the molecule, have been calculated. F. S.

1567. Beryllium Spectrum in the Region λ3367 to λ1964. S. N. Bose and S. K. Mukherjee. *Phil. Mag.* 7. *pp.* 197–200, *Jan.*, 1929.

Measurements were made of the lines in the arc spectrum of beryllium, using a Hilger quartz spectrograph. Various samples of material enabled lines due to impurities to be eliminated and the final results are given in a table, with the values found by Rowland and Tatnall and by Bowen and Millikan [Abstract 117 (1927)] for comparison. The lines λ2351, 2175, 2126, 2056 and 2033, given by Millikan and Bowen as single lines, were found to be doublets with a frequency difference of approximately 2·6. These are most probably triplets due to the triplet P-terms, but the separation given by the spectrograph was only great enough to distinguish P_1 from $P_2 + P_3$. The lines λ1998 and 1964 also just appeared as doublets, but owing to their hazy character, measurements of the doublet separation were not possible. By using sparks between points of metallic beryllium, enclosed in a partially evacuated vessel with a quartz window, an interesting band spectrum was obtained. This is believed to be due to beryllium and consists of bands degraded towards the red. A. W.

1568. Absorption Spectrum of Praseodymium. R. Brunetti. *N. Cimento*, 5. *pp.* 391–403, *Dec.*, 1929.

Studies the spectroscopic classification of the absorption spectra of the trivalent ion Pr'''. Compares the spectra of solutions of various chemical compositions and the spectra of beads at ordinary temperatures and the temperature of liquid air, and studies the polychroism of various crystals. The absorption spectra of solutions and the multiplets of polarised elements of crystals indicate the mean positions of the characteristic radiations of the ion Pr'''. In liquid solutions, in which the thermal movements are translatory and freer than in crystals, the multiplets are lost by widening. In solid solutions like beads, the distribution of the ions is not uniform, but depends upon the temperature of formation. E. E. F. d'A.

1569. Structure of the Third Order Spectrum of Sulphur (SIII). J. Gilles. *Comptes Rendus*, 188. *pp.* 63–64, *Jan.* 2, 1929.

Gives a classified list of forty lines of this spectrum. H. R. R.

1570. Intercombinations and New Terms in the Spark Spectrum of Sulphur SII. L. and E. Bloch. *Comptes Rendus*, 188. *pp.* 160–162, *Jan.* 7, 1929.

Among the new multiplets observed are certain intercombination multiplets which enable the doublet terms to be referred to the same zero as the quadruplets. A correction of 317·20 to the doublet terms of Ingram [see Abstract 171 (1929)] is found to be necessary. W. S. S.

1571. D-Line Excitation by the Green Sodium Band and Dissociation Potential of Sodium Vapour. E. L. Kinsey. *Nat. Acad. Sci., Proc.* 15. *pp.* 37–41, *Jan.*, 1929.

The evidence is discussed that in the fluorescent phenomena of sodium vapour the molecules dissociate into a normal and an excited atom, and that these experiments can be made the basis of the calculation of the heat of dissociation. Experiments were made to determine the conditions under which it is possible to excite the D-lines by the blue-green band of the sodium molecule. This was done by using an intense beam from a 50-ampere carbon arc, which was passed through a large monochromator, and then through a long steel tube, closed by windows at the ends, containing the shorter steel retort. It was shown that the limits of excitation were 4470 and 5240 Å.U. for the D-lines, and that the maximum D-line fluorescence was produced by 4856 Å.U. The maximum blue-green fluorescence was excited by 4930 Å.U. and the short wave-length limit of this fluorescence was 4485 Å.U. It is concluded that the usual interpretation as applied to iodine, for example, is not applicable. It is believed that the process occurring is that atoms are excited to the 2P levels by collisions of the second kind. Excited atoms cannot arise as the result of the dissociation of the molecules, as there is not sufficient energy available for dissociation. A. C. M.

1572. Combination Frequencies of the Infra-Red Bands of Quartz. E. K. Plyler. *Phys. Rev.* 33. *pp.* 48–51, *Jan.*, 1929.

Many observers have studied the infra-red absorption bands of quartz and have found regions of intense absorption at 9μ, $12\cdot5\mu$, 20μ and 26μ. These regions of absorption are assumed to be the fundamental frequencies of quartz. By combining these assumed fundamental frequencies, six bands in the region from 3μ to 9μ are accounted for. Also the writer has experimentally located two bands at $2\cdot72\mu$ and $3\cdot18\mu$ which have not been previously observed. The frequencies of these two bands agree with two combinations of the fundamental frequencies. This gives a total of eleven absorption bands for the ordinary ray of quartz, extending from $2\cdot72\mu$ to 26μ whose frequencies agree, with only small differences, with the calculated values. AUTHOR.

1573. Intensities of Some Fe^+ Multiplets in Arc and Chromosphere Spectra. W. Clarkson. *Phil. Mag.* 7. *pp.* 98–105, *Jan.*, 1929.

The middle fifth of an arc between iron poles was used and the spectrum photographed with a stigmatic grating. Comparison was made with the flash spectrum taken in Lapland in 1927. Intensity measurements were made of the multiplets $2^4F - 2F'$ and $2^4F - 2^4D$. As in nickel and cobalt, the mulitplet summation rules only apply to the total sums of the two multiplets (Ornstein and Bouma). The arc is free from self-absorption and so gives fundamental lines intensities, while the flash sums demonstrate self-absorption. The flash-arc relation is linear, but there are two very abnormal lines. F. S.

1574. Width of Spectrum Lines. B. Trumpy. *Zeits. f. Physik*, 53. 1–2. *pp.* 57–60, 1929.

The various reasons suggested for the widening of lines are enumerated, and of these the effects of impact and of coupling are considered. It is pointed out that these causes are usually associated, and as a new cause a combination of impact and radiation is suggested. F. S.

1575. Intensity of Multiple Lines. A. Rubinowicz. *Zeits. f. Physik,* 53. 3–4. *pp.* 267–273, 1929.

A theoretical paper in which quantum mechanics is applied to the relations of intensity and polarisation of " forbidden " lines corresponding to central-symmetrical one-electron systems. F. S.

1576. Non-Polarisation of Characteristic X-Rays. E. O. Wollan. *Nat. Acad. Sci., Proc.* 14. *pp.* 864–867, *Nov.,* 1928.

By a method based on integrated intensity measurements, it is shown that the $K\alpha$ lines of molybdenum are not polarised more than 1 %.
A. C. M.

1577. Structure of the Compton Shifted Line. J. W. M. DuMond. *Nat. Acad. Sci., Proc.* 14. *pp.* 875–878, *Nov.,* 1928.

The natural breadth of the Compton modified line can be regarded as a Doppler broadening for X-rays scattered by the moving electrons in the dynamic atom just as the temperature broadening is regarded in optical spectra. The structure of the line can be interpreted in such a way as to give the probability distribution of electron momenta in atoms, and the breadth for circular orbits should be proportional to the effective atomic number of the scatterer. Superposed on the natural breadth is an experimental broadening due to the unavoidable inhomogeneity of the scattering angle, but this is least for a scattering angle of 180°. At this angle, too, the shift is a maximum and also the predicted natural breadth is a maximum. A special tube was constructed containing the scattering material and the Seeman crystal spectrograph in a small box supported on the end of the standard Coolidge water-cooled molybdenum target. The primary radiation leaves the target at a small angle to its surface, and the scattered radiation returns in a line parallel to that surface about a millimetre away. The scattering angle is about 176°. Good agreement between observed and calculated line-structure is obtained for aluminium, but the experimentally found distribution for beryllium is wider than theory permits. This is being investigated. A. C. M.

1578. Mirrors as " Equivalent Slits " for X-Rays. H. E. Stauss. *J.O.S.A. and R.S.I.* 17. *pp.* 365–368, *Nov.,* 1928.

As an alternative to the use of fine slits (between lead blocks) for use in X-ray spectroscopy the author describes a simple and effective means of obtaining " equivalent slits," by means of a mirror. By the " equivalent slit " of a mirror is meant the slit which, when placed in the proper position with respect to the image of the source as a source, transmits the same beam as the mirror reflects. The width can be varied by merely turning the mirror and can be measured in terms of the angle of reflection [see also Abstract 1925 (1928)]. The reflected beam is easily separated from the undeviated beam of X-rays when the latter is fairly narrow. The apparatus is easily adjusted by ordinary optical methods. A. B. W.

1579. Röntgen Radiations Excited by α-Particles. W. Bothe and H. Fränz. *Zeits. f. Physik,* 52. 7–8. *pp.* 466–484, 1928. *From the Reichsanstalt.*

By fully utilising the sensitivity to X-rays of the Geiger counter it has been possible to detect and measure the X-rays produced by α-particles in targets situated at appreciable distances from the source (polonium), and thus to examine in considerable detail the conditions of excitation and the properties of the radiations. As an indication of the sensitivity of the method the arrangement is roughly equivalent to an X-ray tube operated with a current of 10^{-10} milliampere. The absorption coefficients of the resulting rays can, however, be measured with sufficient accuracy for satisfactory identification of the wave-lengths. The K-radiations have been identified for a number of elements from atomic number 12 upwards, in addition L-radiations from 34 up, and the M-radiation of bismuth (83). There is no evidence of impulse radiation of wave-lengths comparable with those of the characteristic radiations dealt with. The general form of the excitation curves with varying α-particle velocity has been investigated, and absolute measurements obtained for excitation in aluminium (in a subsidiary experiment). The results indicate that the Thomson theory does not hold for ionisation of the inner atomic levels. The original paper must be consulted, as it contains a great deal of information which cannot be briefly abstracted. H. R. R.

1580. Total Reflectometer for Röntgen Rays. W. E. Laschkarew and S. D. Hertzrücken. *Zeits. f. Physik*, 52. 9–10. *pp.* 739–742, 1928.

An improved form of a total reflectometer for X-rays is described which gives results consistent to within 0·1 to 0·2 %. F. J. W.

1581. Influence of Hydrogen on the L_{III} X-Ray Absorption Edge of Palladium. J. D. Hanawalt. *Nat. Acad. Sci., Proc.* 14. *pp.* 953–958, *Dec.*, 1928.

A Siegbahn vacuum spectrograph was used and the iron K_α lines in the second order of a calcite crystal used for reference. Hydrogen was occluded by electrolysis and also from the gas phase. The lattice parameter $a_0 = 4{\cdot}017$ was less stable in the latter case. It is concluded that the Pd_2H crystal lattice is a face-centred cubic lattice in which the alternate grating points are PdH molecules, the remaining points being occupied by Pd atoms. F. S.

1582. Excitation of X-Ray Spectra by α-Rays. W. Bothe. *Phys. Zeits.* 29. *pp.* 891–893, *Dec.* 1, 1928. *Paper read before the Deut. Naturforscher u. Ärzte, Hamburg, Sept.*, 1928.

The intensities of the X-rays produced by the impact of α-rays on elements are small, and the radiation can only be identified by means of absorption curves. The arrangement made use of for experiments on atomic disintegration was employed, the X-rays passed through aluminium foil into a Geiger counter filled with argon, and the absorption curves for Al, Fe, Ca and Ta were determined; those for the last three elements fall together, while that for Al is distinctly different. The curves for the differential ionisation—that is to say, the ionisation per unit of α-ray path—were obtained; the difference between the behaviour of Al and the other elements is even more marked in these. The curves lie on the ascending part of the Bragg curve, and it is only in the case of Al, the element with the smallest energy of ionisation, that the curve shows signs of bending over towards a maximum. Ionisation takes place far below the range limit given by the J. J. Thomson theory; according to wave mechanics it begins at very small ranges indeed. The output of X-rays rises regularly as the atomic number diminishes. H. N. A.

1583. Measurement of Intensity of X-Rays Scattered by Powdered Crystals. J. Brentano. *Phys. Zeits.* 29. *p.* 893, *Dec.* 1, 1928. *Paper read before the Deut. Naturforscher u. Ärzte, Hamburg, Sept.*, 1928.

The report indicates the importance of simplifying the problem by employing sufficient small regular crystal particles so that the extinction effect can be neglected. Comparative measurements were made with coarse gold powder and with small gold particles. The extinction in the first case had a considerable value. Aluminium and silver were also used, and it was shown that with heavy atoms the scattered intensity increases almost in proportion to the effective charge F and not to F^2. H. N. A.

1584. Physical Purity with X-Ray Powder Photographs. N. H. Kolkmeijer. *Zeits. f. phys. Chem.* 138. *Abt. A.* 5. *pp.* 311–312, *Dec.*, 1928.

The conclusion drawn by Levi (*Gazz. chem. Ital.* 54. 709, 1924) from the identity of the X-ray powder photographs given by red and yellow mercuric oxides, that only one form of the oxide exists, is unjustifiable. It is suggested that both of the samples examined by Levi contained the two forms, the so-called red mercuric oxide consisting of, for example, 99 % red and 1 % of the yellow modifications, and the yellow mercuric oxide of 90 % and 10 % of the red and yellow modifications respectively. F. J. W.

RADIOACTIVITY.

1585. Quantum Theory of the Atomic Nucleus. M. v. Laue. *Zeits. f. Physik*, 52. 9–10. *pp.* 726–734, 1928.

The author corrects the mathematical analysis given by Gamow in his recent theory of the atomic nucleus [see Abstracts 532 and 1231 (1929)]. The physical significance of both constants in the Geiger–Nuttall relation is indicated. W. S. S.

1586. Artificial Disintegration of Atoms and their Packing Fractions. H. Pettersson. *Arkiv f. Mat. Astron. och Fysik, Stockholm*, 21. 1. *pp.* 1–16, 1928. *In English.*

Calculates from Aston's values of the packing fractions the total packing, referred to hydrogen, $\Delta m = Am_H - m_A$, where A is the mass number, m_H the mass of the H atom and m_A the exact atomic mass of the atom considered. $\Delta m \times 1{\cdot}485 \times 10^{-3}$ ergs is the energy corresponding to mass Δm, and can be called the binding energy of the atom $= \Delta W$. $\Delta W/A$ is the average binding energy per proton, neglecting the share of the nuclear electrons in the binding energy. It is probable, however, that in many cases there are protons in the nucleus which are more loosely bound than this, so that it is more correct to consider the difference in energy between the atom to be disintegrated and that resulting from the process. This is done in certain cases in the paper, though difficulties arise when the resulting atom is one whose mass is not known and can only be estimated by means of the packing fraction curve. The author concludes, however, that on this basis the disintegration of a carbon atom into an atom of B^{11} and a hydrogen atom should require at least twice the energy of an α-particle from RaC; with oxygen, on the other hand, disintegration into F^{19} and H should be perfectly feasible. With the same α-particles disintegration of He is shown to be impossible. Lithium and krypton are also considered. The question whether the helium nucleus exists in the nucleus of many of the elements as a subnuclear unit is discussed; reasons are given which are in opposition to the suggestion that in the heavier elements helium is the dominant subnuclear unit. H. N. A.

1587. Artificial Disintegration by Means of α-Particles from Polonium. H. Pettersson. *Arkiv f. Mat. Astron. och Fysik, Stockholm,* 21. 2. *pp.* 1–11, 1928. *In English.*

Gives the results of an investigation on the disintegration of carbon by polonium α-particles with reduced range. When the range is less than 2 cm. no atomic fragments can be observed by the scintillation method in the retrograde direction; α-particles of this range are able to disintegrate aluminium. It cannot be said whether all the atomic fragments observed with greater ranges are H-particles; and some of them may be He nuclei, which would be in accordance with certain views on the constitution of the C nucleus. Some space is devoted to papers by Bothe and Fränz, and an explanation for the positive and the negative results obtained by them in disintegration experiments by means of α-particles from polonium is suggested. Difficulties peculiar to the use of the Geiger counter are pointed out, and other electrical counters, some of which are without the trigger action which complicates the use of the Geiger counter, are mentioned. H. N. A.

1588. Long-range α-Particles of Radium C. K. Philipp and K. Donat. *Zeits. f. Physik,* 52. 11–12. *pp.* 759–766, 1929.

A continuation of the work of Meitner and Freitag [see Abstract 153 (1927)], using the Wilson cloud chamber. Improvements in the apparatus make it possible to take stereoscopic photographs of the tracks at the rate of 200 per hour. 221 long-range tracks have been measured, showing groups with ranges 9·2 and 11·0 cm., and a few particles with still longer ranges. The numbers of particles with 9·2 and 11·0 cm. ranges are 29 and 4 respectively per 10^6 particles of normal range. This is in excellent agreement with the result of Rutherford and Chadwick [see Abstract 2989 (1924)]. About one particle in two million has a range greater than 11 cm. H. R. R.

1589. Passage of α-Rays through Matter. S. Rosenblum. *Ann. de Physique,* 10. *pp.* 408–471, *Nov.-Dec.,* 1928.

Gives a full account of the apparatus used and the experimental details. The α-rays lose their velocity in passing through metals according to the formula $X = K(1 - V/V_0)[1 - \log(2 - V/V_0)]$, where K is a constant characteristic of the metal employed which is a function of the atomic number, X is the superficial mass of the metallic screen, V/V_0 is the ratio of the residual velocity to the initial velocity of the α-rays of ThC′ employed. An expression is also found giving the values of dE/dX for different values of V/V_0 (E is the kinetic energy of the emergent α-particle), the curve has the same general shape as Bragg's curve, and the maxima of the two curves coincide. For the range $X\rho$ of thorium α-rays in metals the formula $X\rho = 36 \cdot 3K$ is provisionally proposed. Two groups of α-rays with a single charge, with about the same velocity as the doubly charged rays, have been shown to exist by means of photography in the radiation from the active deposit of thorium. For the retarding power per atom the expression $N/\sqrt{N+4}$, where N is the atomic number, is found to agree best with the experimental facts. For small atomic numbers the experimental results agree approximately with those deduced from Bohr's theory of atomic structure. H. N. A.

1590. Ranges of β-Rays. B. W. Sargent. *Roy. Soc. Canada, Trans.* 22. *Sect.* 3. *pp.* 179–191, *May*, 1928.

The β-ray absorption measurements of a number of authors have been examined. Curves are given for calculating the mass ranges of β-rays from 25,000 to 1,363,000 e-volts. It is claimed that the values, which are appreciably higher than those usually quoted, are correct to within 10 %. New experiments are discussed on the apparent hardening of the β-rays of RaE on filtration by lead foils. The relative stopping powers of different atoms for the β-rays of RaE are found to increase less rapidly than the respective atomic numbers. H. R. R.

1591. β-Ray Spectrum of Radiothorium as Absorption Spectrum of its γ-Rays. Lise Meitner. *Zeits. f. Physik*, 52. 9–10. *pp.* 637–644, 1928.

The β-ray spectrum of radiothorium freed from its disintegration products was taken by the magnetic method, and six groups of lines were photographed, two exceedingly weak slow lines and four intensive faster ones. The last four come from the L and M levels, and the electrons are shown to be set free by two γ-lines, the energies of which are exactly the same as those of the two K_α lines of the immediate disintegration product of radiothorium, thorium X. It is shown that a relatively very high percentage of the disintegrating radiothorium atoms emits one of the two γ-lines, so that, on the assumption that these lines are really the K_α lines of thorium X, nearly every α-particle of radiothorium in passing through the electron shells of the resulting product excites its K-radiation. The difficulties arising from this explanation are discussed. H. N. A.

1592. Emission γ-Ray Spectrum of Radiothorium. Lise Meitner. *Zeits. f. Physik*, 52. 9–10. *pp.* 645–649, 1928.

In another paper the authoress has deduced from the β-ray spectrum of radiothorium the existence of two γ-lines with the wave-lengths 140 and 145 XU [see preceding Abstract]. Thibaud using the rotating crystal method has found two γ-lines 168 and 145 XU. Thibaud's experiment has been repeated using a tungsten slit, since the line 168 XU is very near the K_α lines of lead and might be due to the lead slit employed by Thibaud. The 168 XU line was observed and found to be a double line, and to be due not to radiothorium, but to one of its disintegration products, thorium B. The γ-rays of thorium B excite the K_α lines of thorium C (a bismuth isotope), and these give the 168 XU double line on the photographic plate, which is identical with the K_α double line of bismuth. H. N. A.

1593. γ-Radiation and Liberation of Heat from Radium and Mesothorium. D. K. Yovanovitch. *J. de Physique et le Radium*, 9. *pp.* 297–306, *Oct.*, 1928.

A calorimetric method is described for the determination of the proportion of mesothorium contained in samples of radium. The method used is based on the measurement of the growth of heat due to the formation of RaTh from MsTh. These measurements have been made by means of a special form of micro-calorimeter which is described. A. B. W.

HEAT.

1594. Investigation of Heat-Transfer Problems. L. Schiller. *Zeits. f. techn. Physik*, 9. 12. *pp.* 490–491, 1928. *Paper read before the Deut. Naturforscher u. Ärzte, Hamburg, Sept.*, 1928.

From both a practical and theoretical standpoint the problem of the flow of heat from a fluid traversing a tube to the wall of the tube is important. The problem is relatively simple only under definite assumptions, *i.e.*, when the place of measurement in a smooth straight tube is sufficiently far from the entrance; when moderate temperature differences are involved; and when the fluid is a gas for which the ratio of conductivity σ to viscosity × specific heat is approximately equal to unity. For this case the theory of Reynolds and Prandtl applies, which allows the transfer of heat to be calculated from the resistance to flow. The above assumptions reduce the problem to that of a single variable, *i.e.*, Reynolds' number (Rey). The author has obtained new experience on the influence of change of value σ with that of Reynolds' number and the quantity z/d (z = distance from entrance; d = diameter of tube). Water from a steam boiler under pressure up to 6 atmospheres and temperature 69° C. to 118° C. was employed. The experimental tube was of brass 0·5 cm. internal diameter and 2 metres long. The results agree well with the theoretical formulæ and also with a recently modified theory put forward by Prandtl. T. B.

1595. Similar Properties and Similar Radiometer Curves of (1) N_2 and CO, and (2) CO_2 and N_2O. E. Brüche and W. Littwin. *Zeits. f. Physik*, 52. 5–6. *pp.* 334–335, 1928.

This is a short note calling attention to the similarity in physical properties of the gases in the two groups as shown in the following table:

	N_2.	CO.	CO_2.	N_2O.
Molecular Weight	28	28	44	44
Heat Conductivity at 0° C. and 760 mm.	$56\cdot10^{-6}$	$53\cdot10^{-6}$	$32\cdot10^{-6}$	$35\cdot10^{-6}$
Coeff. of Internal Friction at 0° C.	$167\cdot10^{-6}$	$165\cdot10^{-6}$	$140\cdot10^{-6}$	$138\cdot10^{-6}$
Mean Free Path at 0° C. and 760 mm.	$599\cdot10^{-8}$	$584\cdot10^{-8}$	$397\cdot10^{-8}$	$387\cdot10^{-8}$

The authors find that the above close similarity is also shown by the radiometer curves which are identical for N_2 and CO, and also for CO_2 and N_2O. Graphs of the curves are given. T. B.

1596. Temperature Distribution in a Rectangular Block on Heating and Cooling. F. Berger. *Zeits. f. angew. Math. u Mechanik*, 8. *pp.* 479–488, *Dec.*, 1928.

This is a mathematical paper in which (1) the temperature at any point in the block at a given time is calculated; and (2) the temperature at a given point in the block is calculated for any time. The method of

Fourier Series is employed. Curves are given showing the temperature distribution in a given plane at a given instant after the beginning of the cooling. It is pointed out that a knowledge of the temperature distribution with time or with position is of importance in the hardening and tempering of steel blocks. T. B.

1597. Specific Heat of Lead at the Temperature of Liquid Helium. W. H. Keesom and J. N. van den Ende. *Phys. Zeits.* 29. *pp.* 896–897, *Dec.* 1, 1928. *Paper read before the Deut. Naturforscher u. Ärzte, Hamburg, Sept.*, 1928.

Measurements made by Keesom and Andrews [see Abstract 391 (1928)] are being repeated with improved apparatus. A peculiarity has been noted at 7° K. for both lead and bismuth, which is attributed to the apparatus. This is being further investigated. F. S.

1598. Measurement of the Temperature of a Gas by a New Method. M. Chopin. *Comptes Rendus*, 187. *pp.* 935–937, *Nov.* 19, 1928.

An aerodynamical method is described for the indirect determination of the temperature of a current of gas [see also Abstract 3059 (1928)], and a comparison is made with the direct observations with a calibrated thermo-junction. A. B. W.

1599. Thermal Diffusion of Rare Constituents in Gas Mixtures. S. Chapman. *Phil. Mag.* 7. *pp.* 1–16, *Jan.*, 1929.

Theoretical considerations have shown that a gradient of temperature existing in a gaseous mixture produces a motion of relative diffusion of the constituents, additional to and independent of any motion of diffusion that may be in progress due to other causes, such as concentration gradients, etc. If a constant temperature gradient be maintained in a closed vessel, a steady state will result, in which there is a concentration gradient along the same direction, of amount sufficient to balance the rates of diffusion due to the gradients. A discussion of the Soret effect in liquids follows, and, finally, the author turns to the real object of the paper, namely, a consideration of the special case of thermal diffusion which bears most closely on the Soret effect as usually measured, *i.e.*, in solutions of small concentration. This results in a simplification of the general formulæ for gas mixtures and the consequent expressions are developed. The chief point of interest evolved is that thermal diffusion in gas mixtures can produce a large proportionate change in the concentration of a rare constituent. After a mathematical treatment of the subject, the author illustrates the theory by application to numerical examples and makes suggestions for experimental work. The application of the results to the determination of the law of force between helium molecules and those of radium emanation is of interest. The radioactive property of radium emanation enables its amount to be determined accurately even in small quantity. The mass ratio of RaEm to He is 55·5, and is shown to be sufficient to justify its application in the present treatment, in the case of a mixture in which 2 or 3 % of the emanation is present. The value of the ratio of the concentrations (c_1/c_1') for $T'/T = 4/3$ is shown to be not less than 1·2, corresponding to an excess concentration of RaEm in the cold region of 20 %. The excess can be much more and can be increased by increment of the ratio T'/T. Suggestions are made for the consideration of the law of force between RaEm and other inert gases. S. G. B.

1600. Changes of Zero in Spirit Thermometers. W. F. Higgins and E. G. Bilham. *Meteorolog. Office, Prof. Notes No.* 51 [10 *pp.*], 1929.

In an attempt to explain the fall of reading noted over a period of some years in the case of certain spirit thermometers, experiments have been carried out to ascertain the effect of the presence of acetone, in the filling liquid, upon the readings of spirit thermometers over a period of time. It is found that in the case of spirit thermometers containing acetone a marked fall of reading is obtained in course of time when the thermometers are exposed to light. It is suggested that the effect is due to the contraction of the liquid consequent upon the formation of condensation products from the acetone under the influence of light. Acetone is known to be a common impurity in commercial methylated spirit, and it is shown that the use of this material either in the commercial or redistilled form should be avoided in the construction of spirit thermometers. No objection appears to attach to the use of pure ethyl alcohol, or acetone-free methyl alcohol, but a mixture of these two substances should be avoided. AUTHORS.

1601. Heat Capacity of Methyl Alcohol from 16° K. to 298° K. and the Corresponding Entropy and Free Energy. K. K. Kelley. *Am. Chem. Soc., J.* 51. *pp.* 180–187, *Jan.*, 1929.

Parks and his co-workers [*Am. Chem. Soc.*, J. 47. p. 338, 1925, etc.], in measurements on the heat capacities of aliphatic compounds, have disclosed certain regularities in the entropies and free energies of members of homologous series. The present paper contains measurements on methyl alcohol down to liquid hydrogen temperatures. The heat capacities from 16° to 298° K. are given graphically and in a table. A transition between the two crystalline forms is found to be of the ammonium chloride type, the heat of transition at the melting point, 157·4° K. being 154·3 cal/mole, and the heat of fusion 757 cal/mole. The entropy, $\int_{16\cdot 5}^{298\cdot 1} dQ/T$, is calculated, and $S_{298\cdot 1}$ for one mole of CH_3OH is $30\cdot 3 \pm 0\cdot 2$ E.U. The free energy is then calculated from the equation $\Delta F = \Delta H - T\Delta S$, giving $F_{298\cdot 1} = -44{,}000$ cal/mole. Data for other substances are to follow later. T. B.

1602. Heat Capacities at Low Temperatures of the Oxides of Tin and Lead and of Ferrous Oxide, Magnetite and Cuprous and Cupric Oxides. R. W. Millar. *Am. Chem. Soc., J.* 51. *pp.* 207–222, *Jan.*, 1929.

In continuation of the general programme of the determination and compilation of thermal and equilibrium data concerning the oxides and sulphides of metals, the heat capacities of SnO, SnO_2, Pb_3O_4 and PbO_2 have been measured from about 70° K. to room temperature, and their entropies at 25° calculated. The method and apparatus employed were those used previously [see Abstract 2759 (1928)]. A second paper deals with the thermodynamic properties of ferrous oxide, magnetite and of cuprous and cupric oxides. H. H. Ho.

1603. Measurement of Specific Heat of Tungsten between 90° and 2600° Absolute. C. Zwikker. *Zeits. f. Physik*, 52. 9–10. *pp.* 668–677, 1928.

The method utilised for the measurement is that due to Eucken and Nernst. The details of the modifications necessary for high temperatures are given. It is shown that at high temperatures C_p increases in linear relationship with the temperature, whilst C_v increases until a maximum value of approx. 8 cal/per gm. atom is reached, when it remains constant. The results can be summarised as below:

For temperatures below 300° Abs. C_p and C_v follow the Debye Law with 310 for the characteristic temperature. For temperatures above 300° Abs. C_p increases linearly with the temperature. C_v, however, increases so far according to the classical theoretical value $3R = 6$ cal/g. atom. It appears, however, from the curve to approach an asymptotic value for temperatures approaching infinity of the value 8 cal/gm. atom as shown above. Full experimental details are given. S. G. B.

1604. Equation of State for Gaseous Mixtures. I. Application to Mixtures of Methane and Nitrogen. J. A. Beattie. *Am. Chem. Soc., J.* 51. *pp.* 19–30, *Jan.*, 1929.

The equation of state proposed by Beattie and Bridgeman [see Abstract 1247 (1929)] has now been applied to mixtures of methane and nitrogen by the use of a simple method for calculating the values of the constants of the mixture from those for pure gases. The constants R, a, B_0, b and c which contain the dimension of density to the first power are combined linearly, thus $B_{0x} = B_{01}(1 - x) + B_{02}x$; the A_0 constant contains the dimension of density to the second power and hence the square root of A_0 is combined linearly, $A_{0x} = [\sqrt{A_{01}}(1 - x) + \sqrt{A_{02}}x]^2$. It is concluded that a single equation can be written for the calculation of pressures for the entire series of mixtures of methane and nitrogen, including the pure gases, from the temperature, density and composition. Since the equation of state is completely algebraic, it can be used for the integration in terms of elementary functions of many thermodynamic relations. H. H. Ho.

1605. Heat Spectrum of Solid and Molten Iron. R. Hase. *Phys. Zeits.* 29. *pp.* 904–907, *Dec.* 1, 1928. *Paper read before the Deut. Naturforscher u. Ärzte, Hamburg, Sept.*, 1928.

The object of the work was to investigate the spectrum of solid and molten iron over a considerable range of temperature, and to compare the radiation with that of the ideal black body for the same temperatures. The results are set out in curves and show: (1) The energy spectrum of radiating iron in both solid and molten form show a path which is close to that of a black body. (2) The absolute amount of the iron radiation is to a large extent dependent on the oxidation of the surface. (3) The radiation of pure white iron in a rare atmosphere shows a close agreement to the Wien's law curve and has a similar maximum in the short wavelength region. The ordinate of the maximum increases similarly to platinum by 6 % with increase of absolute temperature. The constant c is given as 2890. (4) In contrast to pure iron is wrought iron of which the radiation is approximately that of a grey body, but which approximates more closely to black body with rise of temperature. (5) The energy curve of molten iron is continuous in range and according to size and direction is similar to that of the white solid metal. The curves are criticised in detail. S. G. B.

1606. Experimental Contributions to the Radiometer Effect. E. Brüche and W. Littwin. *Zeits. f. Physik*, 52. 5–6. *pp.* 318–333, 1928.

This paper is a preliminary, but fairly full account of work done between the autumn of 1926 and the winter of 1927–28. A radiometer was constructed of a simple and exact geometrical pattern, and in which definite thermal relations could be maintained. It consisted essentially of three thin platinum plates, one of which could be electrically heated, one maintained at a constant temperature, and the middle one had its central portion cut out and suspended by a fine platinum wire. By rotation of the suspension the radiometer pressure on the plate could be measured. The paper gives a photograph of the apparatus, and a series of curves showing the results obtained. Twelve gases were experimented with, *i.e.*, He, Ne, A, H_2, O_2, N_2, air, CO, NO, CO_2, N_2O and CH_4. The principal results obtained were: (1) with small pressures the radiometer effect is a surface effect, independent of the kind of gas and of the geometrical proportions of the apparatus, and merely proportional to the number of molecules per cc.; (2) with medium pressures each gas shows a maximum on the radiometer curve, which proves to be proportional to the length of free path; (3) with greater pressures the effect is an edge or boundary one, which is proportional to the square of the free path and inversely proportional to the pressure. T. B.

1607. Joule Thomson Effect and the Internal Friction of Liquids. Marie Kosinska. *Comptes Rendus*, 187. *pp.* 1037–1039, *Dec.* 3, 1928.

It is shown theoretically that the total energy evolved as heat is given by $dw = d\tau + \mathrm{I}dQ = vdp - \left(T\frac{\partial v}{\partial t} - v\right)dp$, where dp is the drop in pressure in the direction of flow of the fluid and v the volume of flow across a cross-section s. vdp is the internal work, and $d\tau$ or $\left(T\frac{\partial v}{\partial t} - v\right)dp$ is the work produced by the intermolecular pressure of the fluid. If the intermolecular forces were nil it would be necessary to withdraw a quantity of heat $\frac{d\tau}{\mathrm{I}}$ in order to maintain the temperature constant, *i.e.*, the quantity of energy representing the work of diffusion of the molecules of the liquid by thermal agitation. $\mathrm{I}dQ$ represents the energy produced by the intermolecular forces at the given temperature. Writing $\frac{1}{v}\cdot\frac{\partial v}{\partial t} = a$ where a is the coefficient of expansion at constant volume, we get the expression $dw = vdp \,.\, (2 - Ta)$, from which it is shown that dp is proportional to the coefficient of internal friction η. The cases of water and alcohol are worked out as examples, and from the tables it is seen that η and $(2 - Ta)$ are in the same order. It is suggested that the intermolecular forces may possibly change the dimensions of the molecules as manifested by the variation in the coefficients of internal friction. S. G. B.

1608. Van der Waals Equation and Principles of Thermodynamics: Maxwell-Clausius Relation and Clapeyron Formula deduced from this Equation. V. Karpen. *Comptes Rendus*, 187. *pp.* 1039–1042, *Dec.* 3, 1928.

A theoretical dissertation showing that the formula of Clapeyron, as also the Maxwell-Clausius relation, is capable of deduction from the van der Waals equation directly, independently of Carnot's principle. This is verified in the text. S. G. B.

SOUND.

1609. Measurement of Ultrasonic Velocities in Liquids. R. W. Boyle, J. F. Lehmann and S. C. Morgan. *Roy. Soc. Canada, Trans.* 22. *Sect.* 3. *pp.* 371–378, *May*, 1928.

A description is given of experimental determinations of the velocity of high-frequency sound waves (from a quartz piezoelectric oscillator) in columns of liquid contained in tubes. Various modifications of the stationary wave method (Kundt's tube) are described. The liquids examined included distilled water, NaCl solution, ethyl alcohol, methyl alcohol, transformer oil, having velocities 1·47, 1·56, 1·27, 1·22 and 1·58 × 10^5 cms./sec. respectively at ordinary room-temperature (16° C.). The change of velocity in NaCl solution with small changes of concentration was also investigated. Similar measurements were made to determine the temperature coefficients of velocity in pure water and NaCl solution. The frequency of the quartz oscillators used varied from 74,000 to 143,000 periods per sec. [See also Abstracts 746 and 2956 (1927).] A. B. W.

1610. Contribution to Theory of Hearing. Mode of Vibration of the Basilar Membrane. G. v. Békésy. *Phys. Zeits.* 29. *pp.* 793–810, *Nov.* 15, 1928.

After some reference to different theories of hearing, a description is given of a model ear with physical properties to imitate, as closely as possible, those possessed by the human ear. It is inferred that there is considerably greater damping in the ear resonators than is generally assumed to be the case, and the assumption that the damping is almost aperiodic is partly confirmed. By the use of stroboscopic illumination of the rubber membrane in the model ear it was found that the membrane vibration consisted of a strongly damped train of waves. There is present also a pair of vortices which are displaced along the membrane when the frequency of the exciting vibration is altered. It is supposed, from a physiological experiment, that there is a parallel action in the human ear. Observation of the vibration of a dead human basilar membrane *in situ* confirms the presence of a progressive train of waves along the membrane. G. E. A.

1611. Radiating and Directional Properties of Sound Sources. H. Backhaus. *Zeits. f. techn. Physik*, 9. 12. *pp.* 491–495, 1928. *Paper read before the Deut. Naturforscher u. Ärzte, Hamburg, Sept.*, 1928.

It follows from theoretical considerations that an acoustical source has a feeble radiating power for wave-lengths great in comparison with the dimensions of the sounding body. The mode of vibration of the breast of a violin was investigated by carrying on the violin a bronze leaf which formed one plate of a condenser-microphone in a high-frequency circuit [see Abstract 2418 (1926)]. The low-frequency vibrations were amplified, and were recorded by oscillograph, and the mode of vibration of the surface was ascertained. The instrument employed was a Stradivarius, and it was found to give an irregular polar curve of radiation, the greater part of the energy being radiated within an angle of 20°. G. E. A.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

1612. Electronic Waves and the Electron. J. J. Thomson. *Phil. Mag.* 6. *pp.* 1254–1281, *Dec.*, 1928.

Recent experiments have shown that a moving electron is accompanied by a train of waves. In this paper it is shown that if the structure of the electron were such that a point charge or something analogous to it formed a nucleus surrounded by a certain system (see below), then the motion of the electron would from the ordinary laws of electrodynamics give rise to a train of waves whose wave-length is related to the velocity as indicated by G. P. Thomson's experiments. These electronic waves travel through an ether modified by the enveloping nuclear system which can be regarded as a sphere made up of parts which can be set in motion by electric forces and so produce the effects of electric currents. Such a system might consist either of a distribution of discrete lines of force, or of a number of positively—and negatively—electrified particles distributed through the sphere of the electron. These would behave like free particles, even though the opposite charges were bound together in doublets, if the frequency of the forces acting upon them were large compared with the natural frequencies of the doublets. The properties of a structure of this kind are discussed, and it is shown that the sphere of the electron would have a definite period of vibration whose frequency is proportional to the square root of the number of electrified systems per unit volume. These vibrations are not accompanied by any radiation of energy, so that when once started they are maintained for an indefinite time. The electron has thus, in addition to the steady electric field due to the negative charge on the nucleus, an alternating field in which the energy remains constant since there is no radiation. The oscillating field is the seat of energy, and thus the total energy of the electron is that due to the charge on the nucleus plus that due to the oscillating field. This is important in connection with the calculation of the size of the electron, which has previously been deduced on the asumption that the energy due to the charge in the nucleus accounts for the whole of the energy. H. H. Ho.

1613. Charge of an Electron. A. S. Eddington. *Roy. Soc., Proc.* 122. *pp.* 358–369, *Jan.* 1, 1929.

In the wave theory the most elementary appearance of e is in the wave equation for two electrons (or an electron and a proton); it occurs in the combination $hc/2\pi e^2$ as the coefficient of certain terms. This combination is dimensionless, a pure number, which according to Millikan's data is 137·1; but the author advances a mathematical theory which would require it to be 136. He uses the exclusion principle in the form given by Fermi and Dirac, that the ψ functions pertaining to a pair of electrons must be antisymmetrical; combined with the theory of relativity this seems to lead to the value 136, the number of symmetrical terms in an array of 16 rows and columns. This implies that space with 16 conceptual dimensions is made use of in the mathematical treatment, the conception being a corollary to the introduction of matrices by Dirac;

they need not describe reality, but they describe the mathematical scheme which is at present the accepted mode of solving some of the problems of reality. It is suggested that it is necessary to envisage a wider principle of relativity which admits, in addition to a rotation in ordinary space and time, a " rotation " in space of higher dimensions which will interchange the identity of two electrons. This leads to the idea of a flow of identity, which makes a spurious contribution to the calculated stresses.
H. N. A.

1614. Determination of the Volta Effect for Space Charge Measurements according to the Thomson Method. F. Lindholm and M. Bider. *Helv. Phys. Acta,* 1. 9. *pp.* 537–550, 1928. *In German.*

The author describes a series of experiments carried out to find the result of using different materials for the cage and different collectors on the volta effect, and consequently on space charge measurements. The results are complex since the kind of metal, the nature of its surface, its size and the coating on the collector all have an effect. The humidity of the air and consequently the dryness or otherwise of the metal surface influence the Volta effect very largely. The use of the Thomson cage method is thus limited on account of the variation of the Volta effect between collector and cage, and it is necessary to use the same material for both and to measure simultaneously the Volta effect at the cage and the space charge, and so bring the two into relation [see also Abstract 754 (1927)]. R. S. R.

1615. Development of Electricity by Torsion in a Crystal of Quartz. E. P. Tawil. *Comptes Rendus,* 187. *pp.* 1042–1044, *Dec.* 3, 1928.

It is shown that torsion exerted about the optical axis of a crystal of quartz will produce electric charge. The note states that if torsion is exercised, electricity is generated on the envelope of a cylinder cut into a crystal of quartz parallel to the optic axis. A charge of reverse sign appears simultaneously on the faces at right angles to the optic axis. On reversing the direction of torsion the charges are reversed. The charges balance one another and disappear when the torsion is withdrawn and the equilibrium position is recovered. The quantity of electricity created is proportional to the amount of torsion. The charge will be positive on the surface of the crystal when the torsion is in the direction of its optical rotation. Thus lævorotatory and dextrorotatory crystals give charges of opposite sign for torsion in the same direction. Full experimental details and observations are recorded. S. G. B.

1616. Triboelectricity and Friction. Part IV. Electricity due to Air-blown Particles. P. E. Shaw. *Roy. Soc., Proc.* 122. *pp.* 49–58, *Jan.* 1, 1929.

Experiments are described which are designed to explain such effects as electric sandstorms and snowstorms, electric flashes seen in the ejectamenta from volcanoes, and electric charges and sparking of organic powders in certain industrial processes. In this group of effects charges are produced by the impact of like particles. The apparatus used provides for the separate measurement of the charges arising on wind-blown particles, on surfaces of one material on which the particles are blown, and on the issuing air. It is shown that considerable charges arise, even when the particles and surfaces are chemically identical, thus indicating that the Volta effect is not sufficient to account for all the charge. Physical differences of the surface, *e.g.*, strain effects, are, therefore, suggested as contributory factors to triboelectric charges. T. B.

1617. Frictional Electricity. L. Wolf. *Ann. d. Physik,* 1. 2. *pp.* 260–288, *Jan.* 19, 1929.

An experimental study of the production of electricity by friction between metallic and insulating surfaces, under conditions which are made as definite as possible. Regular and reproducible results are obtained for the magnitudes of the charges developed, and for the effects of electric fields on the sign and magnitude of these charges. The results are discussed in terms of the " solution pressure " theory of electrification. H. R. R.

1618. Excitation of Frictional Electricity between Metals and Non-Conductors in Relation to the Pressure of the Surrounding Gas and the Condition of the Metal. W. Kluge. *Ann. d. Physik,* 1. 1. *pp.* 1–39, *Jan.* 2, 1929.

An apparatus is described by means of which the electrical properties of platinum, gold and palladium foil were measured in a high vacuum. Silk, used in rubbing the metals, was attached to a rotating wheel, and measurements were made of the pressure applied in rubbing, the work expended in friction, the resulting voltage of the foil, and the electrical state of the silk. In a high vacuum the polarity obtained is always reproducible, and the normal polarity of these metals is negative in the conditions mentioned. The amount of the charge due to a given rubbing depends on the surface condition of the metal; it is very small at atmospheric pressure, increases in a vacuum, and is further increased after the metal has been heated to redness. When air is again allowed to surround the metal, the latter returns to its previous condition. A temporary positive polarity of the platinum is ascribed to the presence of Pt dust. G. E. A.

1619. Atmospheric Electricity. G. Aliverti and A. Rostagni. *Accad. Sci. Torino, Atti,* 63. 11*a*–14*a*. *pp.* 277–286, 1927–1928.

Measurements of the atmospheric electricity made on the Col d'Olen with a C. T. R. Wilson apparatus, modified according to Lutz. Within limits, in the stratum adjacent to the earth, there is a number of positive ions per cub. cm. equal to the sum of the corresponding numbers of ions of the two signs in the upper strata. Diagrams given for the gradient, the current, and the conductivity. On mountains the conduction-current is direct downwards, and has a complex medium value not far from the normal. Further work is required in order to connect atmospheric electricity observations with meteorological data, but the work will not be easy. A. D.

1620. Probability of Lightning Strokes. U. Yoshida, H. Fukushima and M. Iso. *Kyoto Coll. Sci., Mem.* 11. *pp.* 451–468, *Nov.,* 1928.

The authors made a series of experiments with a metallic sphere having a small protuberance on the lower surface, suspended above an earthed metallic plate. The effect of a lightning conductor could be found by having a sharp needle passing through a small hole at the centre of the plate. The distribution over the plate of sparks from the sphere was found by covering the plate with black paper. Tests were made only with the sphere positive and a slow succession of sparks. Calculations are made based on probability for the distribution of density of lightning strokes for cases with and without the lightning rod. The experimental and calculated results agree very well. The scale of the experiments is too small for them to be extended to the case of natural lightning and the lightning rod. R. S. R.

1621. Charges of Thunder Clouds. D. Nukiyama and H. Noto. *Japanese Journ. of Astron. and Geophys.* 6. 2. *pp.* 71–81, 1928.

The authors used an antenna stretched above a roof garden and connected to a sensitive moving-coil galvanometer, observations being made photographically and by eye when thunder clouds passed near. Some of the photographic results obtained are reproduced. The authors conclude that the thunder clouds generated in the inland parts of Japan are of the Simpson's type of polarisation, while those generated near the coast are of the Wilson type [see also Abstracts 252 (1929) and 1085 (1926)]. R. S. R.

DISCHARGE AND OSCILLATIONS.

1622. Exhaustible Spark Tube. C. Leiss. *Zeits. f. Physik,* 52. 9–10. *pp.* 750–751, 1928.

Briefly describes a new type of spark discharge tube which can either be connected directly to a vacuum spectrograph or placed directly in front of the slit of such a spectrograph, and which can also be evacuated. The tube, which is made of glass, is T-shaped, the end of each limb being coned. The electrodes are placed in the two limbs which have a common axis, and are arranged to be movable to allow of variation of the spark distance. The third limb is capable of being closed by different devices depending on the use of the tube. External observation of the spark is easily made through the glass walls of the tube. R. C. F.

1623. Control of Current in a Discharge Tube by Means of a Magnetic Field. R. F. Earhart and C. B. Green. *Phil. Mag.* 7. *pp.* 106–115, *Jan.*, 1929.

With discharge tubes in which the electrodes were flat and at a distance of the order of 1 mm. it was found that the application of a magnetic field perpendicular to the faces of the electrodes might increase the current through the tube by several hundred per cent. if the pressure were properly adjusted. The variations observed were found to depend on the distance between the electrodes, the gas pressure, and the magnitude of the current through the tube. Curves for hydrogen were found to be of the same type as those for air. With transverse magnetic fields current increases were also found when the distance between the electrodes was small. Satisfactory theoretical explanations are given of the effects observed. A. W.

1624. Low-Voltage Sparks as Spectroscopic Sources. A. Occhialini. *Accad. Lincei, Atti,* 8. *pp.* 389–392, *Nov.* 11, 1928.

These sparks are obtained by using as discharge electrode an incandescent kathode consisting of the carbon of an auxiliary arc and a cold anode, and by charging a condenser on the discharge interval with continuous current through a resistance sufficiently great to impede the formation of the arc. The condenser, charged slowly, is discharged suddenly when the explosive potential, in this case extraordinarily low, is reached. With capacities of a few microfarads, which, given the low potential required, are easy to realise with ordinary condensers, the discharge takes place with characteristic noise, and with the appearance of the condensed sparks of bobbins and electrostatic machines, of which they possess the spectral characteristics. An arrangement is described for obtaining these sparks by suppression of the auxiliary arc and by effecting the charging of the condenser by means of alternating current. T. H. P.

1625. Distribution of Gliding Sparks on a Surface Coated with a Granular Conductor. U. Nakaya and T. Terada. *Inst. Phys. and Chem. Research, Sci. Papers Nos.* 168–169. *pp.* 237–264, *Dec.* 18, 1928. *In English.*

In previous work [see Abstract 2427 (1926)] a similarity was noted between the distribution of long gliding sparks on the surface of a fabric coated with aluminium powder and that of the stream lines of the electric current which would be obtained when the surface is replaced by a homogeneous conducting plate. Further results are here given, and these are discussed, taking account of the rectangular boundary, which was neglected in the previous paper. A. W.

1626. Evaporation at the Kathode in the Mercury Arc. J. v. Issendorff. *Phys. Zeits.* 29. *pp.* 857–864, *Dec.* 1, 1928.

Experimental determinations of the evaporation at the kathode in a mercury vapour arc for different surface temperatures showed that the quantity evaporated varied largely with the temperature, but only slightly with the arc current. As regards evaporation, the results show a vanishingly small loss of material from the kathode; there may even be a gain of material due to incoming ions. As regards the quantity ejected from the surface, this increases more than linearly with the current. A critical discussion is given of the balance of energy at the kathode in the mercury vapour arc, with special reference to the results of Compton and van Voorhis (Abstract 2592 (1927)]. A. W.

1627. Transport of Material in the Iron Arc. H. Schmick and R. Seeliger. *Phys. Zeits.* 29. *p.* 864, *Dec.* 1, 1928.

In the theory of the arc advanced by Compton, Güntherschulze, and Seeliger the balance of energy at the kathode plays the principal part. One of the assumptions on which this balance of energy is based is that the loss of material at the kathode depends essentially only on the neutral evaporation at the incandescent surface and is proportional to the current and time. This loss of material in theoretical discussions has been treated as a constant. The results obtained by v. Issendorff for the mercury vapour arc [see preceding Abstract] show that the above assumption is not justified. Results obtained by the present authors with an iron arc point to the same conclusion. The theory will in consequence have to be revised in the light of the results now obtained. A. W.

1628. Groups of Electrons in the Geissler Discharge. K. G. Emeléus and W. L. Brown. *Phil. Mag.* 7. *pp.* 17–31, *Jan.*, 1929.

By measurements of collector characteristics in the Geissler discharge from a cold kathode in argon, neon, hydrogen and oxygen, it is shown that a group of fast electrons of approximately Maxwellian velocity distribution (average energy about 25 electron-volts) is present in the negative glow and, at low pressures, in the Faraday dark space. These electrons, it is suggested, enter the negative glow from the kathode dark space, and are maintained by a process which is the reverse of ionisation by collision. Further evidence is also given for the persistence of two groups of slow electrons in the discharge, an effect due possibly to the Ramsauer minimum of the free paths of electrons. W. S. S.

1629. Arcs with Small Kathode Current Density. J. Slepian and E. J. Haverstick. *Phys. Rev.* 33. *pp.* 52–54, *Jan.*, 1929.

Arcs with kathode current densities of less than 100 amperes per $cm.^2$ have been found to exist at gas pressures of from 10 to 50 mm. The theory that electrons are drawn from the kathode by intense electric fields maintained by space charges cannot apply to these arcs. AUTHORS.

1630. Spark Potentials at Pressures below Atmospheric Pressure, and the Minimum Potential with respect to the Electrode Function. F. Klingelfuss. *Zeits. f. Physik*, 52. 9–10. *pp.* 746–747, 1928.

This paper is an extension of the theory previously developed by the author [see Abstract 1267 (1929)]. A simplified form of the elementary energy equation is obtained, which appears to be more in accordance with the experimental results. Certain minor corrections to the author's previous paper are also given. R. C. F.

1631. Spark Potential at Pressures below Atmospheric Pressure, and the Minimum Potential with respect to Electrode Function. F. Klingelfuss. *Zeits. f. Physik*, 52. 11–12. *pp.* 890–891, 1929.

The author shows that remarkable coincidence with experimentally obtained constants is obtained, for the same constants, from a calculation whereby the function $V_v = \rho(p, \delta \ddot{u})$ is represented as an amplified Einstein equation. Only the minimum potential is considered, and the calculation is based on the author's previous theoretical work. [See Abstract 1267 (1929) and preceding Abstract]. R. C. F.

1632. Investigations of the Influence of the Kathode Material on the Sparking Potential made with the Geiger Counter. O. Klemperer. *Phys. Zeits.* 29. *pp.* 947–948, *Dec.* 15, 1928.

Makes use of the theory of the counter developed in a recent paper. Counter "points" were prepared of different metals, Au, Ag, and Cu, minute spheres being used of 0·04 to 0·12 mm. radius at the ends of fine wires of 0·02 mm. thickness; steel and aluminium were also used in the form of needles or pieces of wire. In CO_2, no perceptible difference was found for the different points, the limiting voltage V_0 was between 600 and 650 volts. In air, Pt, Au, Ag, Cu and steel heated or dipped in nitric acid all gave $V_0 = 600$ volts, untreated steel $V = 580$, Al $V_0 = 500$. In hydrogen, a series was found, steel excepted, parallel with the Volta potential series. In argon, the differences were much larger, and certain irregularities were noted. Further remarks are made about the mode of action of the Geiger counter and the effects of roughness of the "point," and of traces of foreign substances such as alkaline salts. H. N. A.

1633. Heat Passage and Glow Discharge. J. Schmekel. *Phys. Zeits.* 30. *pp.* 81–82, *Feb.* 1, 1929.

Holms' similarity-law is not followed by the density of current on the sphere kathode of a glow discharge. It was thought that possibly the high kathode-temperature altered the density of the gas; but the measured temperatures were found equal with spheres of different radius. It would seem to follow that equal gas temperatures will always be associated with equal gas densities; but this is found not to be the case. [See Abstract 1270 (1924).] A. D.

1634. Ionisation Processes of Iodine Interpreted by the Mass-Spectrograph. T. R. Hogness and R. W. Harkness. *Phys. Rev.* 32. *pp.* 784–790, *Nov.*, 1928.

Positive ions are formed by electrons of definite energy, and are accelerated and then deflected magnetically around a semicircle into a Faraday cylinder. The relative numbers of ions I^+, I_2^+ and I_3^+ were measured as a function of the pressure from 2×10^{-5} to 4×10^{-3} mm. In the primary process of electron collision, I^+ and I_2^+ were both formed. I_2^+ was also formed in secondary collision from I^+ by the process $I^+ + I_2 = I_2^+ + I$. I_3^+ was formed from I_2^+ by the process $I_2^+ + I_2 = I_3^+ + I$. The disappearing potentials of I^+ and I_2^+ were found to be identical, 9·3 volts. Three negative ions I^-, I_2^- and I_3^- were found to exist in quantities comparable with those of the positive ions, and their pressure-intensity relationships were determined also. I^- is formed near the filament and in the ionisation-chamber. I_2^- and I_3^- are formed as the result of the secondary collision of I^- and I_2^- with I_2 molecules. A. C. M.

1635. Ionised Gases in High-Frequency Fields. H. Gutton. *Comptes Rendus*, 188. *pp.* 156–157, *Jan.* 7, 1929.

In the experiments described, hydrogen contained in a long tube was ionised by applying to the tube a periodic e.m.f. of wave-length 88 metres. At the centre of the tube two measurements were made, (1) the transverse conductivity determined from the current between platinum electrodes sealed in the glass, across which a steady potential of 4·12 volts was applied; (2) the resonance current by applying a high-frequency field transverse to the tube, using external electrodes. The values of the conductivity i corresponding to resonance for four wave-lengths λ of the high-frequency field were found to satisfy $\lambda^2 i^{0\cdot 75} =$ constant (λ, 4·8 to 1·3 metres). The bearing of the results on the proper period of oscillation of ions, and on the propagation of wireless waves in the upper atmosphere, is discussed briefly. W. S. S.

1636. Effect of a Magnetic Field on Resonance Phenomena in Ionised Gases. H. Gutton. *Comptes Rendus*, 188. *pp.* 385–386, *Jan.* 28, 1929.

Continuing the experiments described in a previous paper [see preceding Abstract], the effect of applying a magnetic field along the axis of the tube was examined. In the absence of the magnetic field, the curve relating resonance current to transverse conductivity for a fixed frequency of the high-frequency field, showed a simple dip corresponding to resonance between the ionised gas and the field. On applying the magnetic field, the dip or absorption band was separated into two similar bands, the effect being precisely similar to the Zeeman effect. The amount of the separation is shown to lead to a value of $e/m = 1\cdot 61 . 10^{-7}$ e.m.u., which is sufficiently near the value for an electron to confirm the view that it is the electrons which are involved in the effect. W. S. S.

1637. Oscillations in Ionised Gases. L. Tonks and I. Langmuir. *Phys. Rev.* 33. *pp.* 195–210, *Feb.*, 1929.

A simple theory of electronic and ionic oscillations in an ionised gas has been developed. The electronic oscillations are so rapid (*circa* 10^9 cycles) that the heavier positive ions are unaffected. They have a natural frequency $\nu_e = (ne^2/\pi m)^{\frac{1}{2}}$ and, except for secondary factors, do not transmit energy. The ionic oscillations are so slow that the electron density has its equilibrium value at all times. They vary in type according to their wave-length. The oscillations of shorter wave-length are similar to the electron vibrations, approaching the natural frequency $\nu_p = \nu_e(m_e/m_p)^{\frac{1}{2}}$ as upper limit. The oscillations of longer wave-length are similar to sound waves, the velocity approaching the value $v = (kT_e/m_p)^{\frac{1}{2}}$. The transition occurs roughly (*i.e.*, to 5 % of limiting values) within a 10-fold wave-length range centring around $2(2)^{\frac{1}{2}}\pi\lambda_D$, λ_D being the "Debye distance." While the theory offers no explanation of the cause of the observed oscillations, the frequency range of the most rapid oscillations, namely, from 300 to 1000 megacycles agrees with that predicted for the oscillations of the ultimate electrons. Another observed frequency of 50 to 60 megacycles may correspond to oscillations of the beam electrons. Frequencies from 1·5 megacycles down can be attributed to positive ion oscillations. The correlation between theory and observed oscillations is to be considered tentative until simpler experimental conditions can be attained. AUTHORS.

1638. Mobility of Positive Ions in Flames. H. E. Banta. *Phys. Rev.* 33. *pp.* 211–216, *Feb.*, 1929.

Mobility of positive ions of K, Rb and Cs in the Bunsen flame.—The mobility was calculated from measured values of the current density, kathode drop of potential, and the thickness of the layer at the kathode in which the potential varies rapidly. The excess of ionisation over recombination in the layer was assumed to be proportional to $(1 - x/x_1)^m$, where x is the distance from the kathode, x_1 the thickness of the layer at the kathode, and m is a constant. J. J. Thomson supposed that $m = 0$, and P. E. Boucher took $m = 1$. The value calculated for the mobility depends on the value assumed for m. The results give, with $m = 2$, a value of 1·8; with $m = 3$, a value of 1·07 cm./sec. per volt/cm. for the mobility. It is found that the mobility is the same for salts of Rb, Cs and K, and that it does not depend on the concentration of the salt. A small increase of mobility with electric intensity is indicated by the results. AUTHOR.

1639. Radiometer Effect of Positive Ions. C. T. Knipp and W. S. Stein. *Phil. Mag.* 7. *pp.* 70–79, *Jan.*, 1929.

The investigation is designed to study the nature of the force exerted by a positive ray beam and to arrive at an explanation of the phenomenon. The number of ions, their velocity, and the number striking the vane per sec. are known, and, therefore, it becomes possible to predict the direct mechanical force due to the beam when the ions lose all their momentum upon striking the vane. A method employing a torsion beam is employed, and by a simple formula the force necessary to twist the suspension through unit twist can be calculated and evaluated. A full description of the tube, etc., used is given. The results show that contrary to previous thought at least a part of the bombardment of a beam of positive rays results in direct mechanical effect. From the tables it is seen that the value of the direct mechanical effect in the present case is 71 % of the value calculated by theory. The proportionality between the radiometer and mechanical effects is discussed and tentatively taken as 1 : 4. Taking the residual air effect as 4 %, it is assumed that the radiometer effect is about 28% and the mechanical effect about 68 %. The proportion between these effects also appears to be affected by the material and thickness of the vane. Pressure has also a marked effect on the results, and a pressure of 0·0009 mm. of Hg slowed the rays down sufficiently so that their actual force on the vane was only 39 % of the calculated value. Further work is proceeding, and definite data and facts are not yet available on many points. S. G. B.

1640. Change of Emission of Ion Rays with Time. O. Birkenberg. *Ann. d. Physik*, 1. 1. *pp.* 157–168, *Jan.* 2, 1929.

Wires coated with salts from solution or the molten state when heated give a constant emission, and maintain it indefinitely in a vacuum or in the presence of dry gases. Water vapour increases the emission from salts soluble in water; insoluble salts are unaffected. Salts which have been sublimed in air on to a platinum wire and heated until the emission is constant, after standing in a vacuum or in the presence of moist or dried gases show an initial increased emission. If sublimation is carried out in vacuo, this reversion to a state of increased emission does not occur. These results are explained by assuming that the salts occlude impurities, such as gas molecules, which set up a weakening of the crystal lattice. F. J. W.

1641. Ion Rays. J. Kahra. *Ann. d. Physik*, 1. 1. *pp.* 135–155, *Jan.* 2, 1929.

Carefully purified lead bromide, iodide and fluoride emit only negative ions. The emission decreases with time to an approximately constant value. The results are in agreement with Schmidt's theory [see Abstract 2128 (1927)] that only those ions are emitted which are responsible for electrolytic conduction. A weak positive emission, noticed above 500°, is ascribed to the platinum wire used to support the salt, and to the decomposition of the salt. Besides the reversible emission due to the electrolytic dissociation of the salt there is also probably an irreversible emission caused by weaknesses of the crystal lattice. Experiments designed to increase the emission by irreversibly loosening the lattice were unsuccessful. It is suggested that the initial increase of emission with time which occurs with salts containing occluded gases is due to such irreversible weakening of the lattice. A number of glasses were examined and found to emit only positive ions in conformity with Schmidt's theory. Negative ion emission occurred only at the highest temperatures. F. J. W.

1642. Release of Electrons from Metal Surfaces by Slow Positive Ions. O. Klemperer. *Zeits. f. Physik*, 52. 9–10. *pp.* 650–653, 1928.

The probability of the release of an electron from a metal surface by a positive ion is calculated from known data in two essentially different ways; firstly from known current voltage measurements of the Townsend discharge, and secondly from the minimum spark potential and the energy required to form a pair of ions in the gas. A table gives the number of electrons released per 1000 colliding ions as a function of the mean kinetic energy of the ions calculated from the results of Townsend and his school, of Spath and Dubois, and as calculated by the author by the second of the above methods. The agreement is good. H. N. A.

1643. Effects of a Longitudinal Magnetic Field on Pencils of Slow Electrons (Periodic Concentrations and Dilatations). J. Thibaud. *Comptes Rendus,* 188. *pp.* 54–56, *Jan.* 2, 1929.

Experiments are described in which a pencil of electrons is passed along the axis of a current-carrying solenoid. By altering the current in the solenoid or the velocity of the electrons a number of remarkable effects are observed, the cross-section of the pencil as shown by the fluorescence produced in the gas being made to vary from 0·2 mm. to 100 mm. diameter (at 30 cm. from the source). The experimental laws governing the effects observed are summarised. W. S. S.

1644. Periodic Concentration and Dilatation of a Pencil of Slow Electrons produced by a Longitudinal Magnetic Field. J. Thibaud. *Comptes Rendus,* 188. *pp.* 158–160, *Jan.* 7, 1929.

A simple theory is given of the periodic concentration and dilatation of a pencil of slow electrons directed along the lines of force of a magnetic field. Agreement with the laws found experimentally [see preceding Abstract] is obtained. [See Abstract 1099 (1927) for a theory of the concentration effect, due to Busch.] W. S. S.

1645. Polarisability of an Electron Ray. F. Wolf. *Zeits. f. Physik,* 52, 5–6. *pp.* 314–317, 1928.

If the electron is considered to be a magnetic dipole, which, for example, would be the case if the electron has rotation as suggested by Goudsmit and Uhlenbeck, it must in passing through a magnetic field assume a direction parallel or anti-parallel to the lines of force, and hence must assume a state of polarisation. The experiments described by the author were undertaken to detect this polarisation if possible, but they failed to discover any such effect. T. B.

1646. Polarisation of Electron Waves. A. F. Joffé and A. N. Arsénieva. *Comptes Rendus,* 188. *pp.* 152–153, *Jan.* 7, 1929.

An attempt to detect polarisation in an electron wave stream by successive reflections at two mirrors gave a negative result. The electrons were incident on the mirrors in one case at 10°, and in another case at 30°. The electron velocities worked with varied from 80 to 6400 volts. Another experiment showed that a magnetic field applied in various likely planes produced no effect on the coefficient of diffusion of the electrons. These results are in accord with theory [see Abstract 562 (1929) and the following Abstract]. W. S. S.

1647. Impossibility of Polarising Kathode Waves by Reflection. J. Frenkel. *Comptes Rendus,* 188. *pp.* 153–155, *Jan.* 7, 1929.

Dirac's relativistic form of the wave equation is used to show that no polarisation of electron waves is obtainable by reflection at a metallic surface. W. S. S.

1648. Photoelectric Behaviour of Mercury when Passing from the Liquid to the Solid State. Margarete Grützmann. *Ann. d. Physik,* 1. 1. *pp.* 49–73, *Jan.* 2, 1929.

Preliminary experiments showed spurious effects, which had to be avoided if satisfactory results were to be obtained. It appeared that it was necessary to cause the temperature to pass slowly through the value − 40° C. Slow cooling gave the best results, and this was carried out by the method of Ives and Johnsrud, using cold air from a flask containing liquid air; heat was supplied to this by a heating spiral which regulated the rate of evaporation. It was found that the photoelectric effect remained constant during the whole process, and that the change of state in the mercury had no effect. Some remarks are made on the theory of the phenomenon. H. N. A.

1649. Photoelectric Charge of Ultramicroscopic Particles. Maria v. Olsufjew. *Helv. Phys. Acta,* 1. 9. *pp.* 551–577, 1928. *In German.*

Calculates the maximum charging of an ultramicroscopic metallic particle illuminated by a mercury lamp as a function of the field in a Millikan condenser. Takes into account Yang's theory of the charge produced on the particle by the condenser field itself. Argon is used as the gas in order to avoid inelastic impacts of electrons. The observed values agree with the calculated ones. E. E. F. d'A.

1650. Photoelectric Effect at Low Temperatures. J. C. McLennan, L. A. Matheson, and C. D. Niven. *Roy. Soc. Canada, Trans.* 22. *Sect.* 3. *pp.* 279–288, *May,* 1928.

For given spectral bands isolated by filters, the current varies with the voltage applied to the cell. Each curve on a graph represents the effect at a definite temperature. The current for each band decreases with the temperature. For longer wave-lengths the variation is greater. In the case of the deep red the current is entirely stopped at 21° K. The threshold has evidently moved past this band to shorter wave-lengths. The photoelectric absorption band can be explained on the basis that most of the energy necessary to eject a photoelectron is used in tearing the electron from the parent atom in which we are already familiar with the existence of the stationary states. This conception, if true, will entail little revision of our ideas. Thus it appears that there is an intimate connection between the work function and the absorption coefficient so they may not be treated as independent variables. E. E. F. d'A.

1651. Photoelectric Phenomenon in Thermionic Valves. Q. Majorana. *Accad. Lincei, Atti,* 7. *pp.* 801–806, *May* 20, 1928. *N. Cimento,* 5. *pp.* 404–412, *Nov.,* 1928.

If in a three-valve amplifier the grid of the first valve is left unconnected, and is illuminated with strong light pulsating at musical frequency, a note sounds in the telephone. The amplifier may be transformer coupled. The author traces the effect to a photoelectric action of a film of copper oxide covering the grid filament. E. E. F. d'A.

1652. Photoelectric Effect in Thermionic Valves. Q. Majorana. *Accad. Lincei, Atti,* 7. *pp.* 877–880, *June* 1, 1928.

Further investigation of the photoelectric effect observed in a triode valve [see preceding Abstract]; the author has studied various substances covering the grid instead of copper oxide. All the substances which are found to be effective are poor conductors, like galena, antimonite, and thallium sulphide. The metals which show the Hallwachs effect most strongly do not respond to the intermittent light. E. E. F. d'A.

1653. Direction of Emission of Photoelectrons. P. Auger. *Comptes Rendus,* 187. *pp.* 1141–1142, *Dec.* 10, 1928.

Further measurements have been made using the $K\alpha$ radiation of molybdenum, whose wave-length (0·71 Å.U.) is much greater than that of tungsten (0·21 Å.U.). The angle of bipartition was found to be 77°, the mean cosine 0·169 and the asymmetry factor 1·9. [See Abstract 273 (1929).] A. W.

1654. Influence of Hydrogen on the Photoelectric Emission of Potassium. R. Suhrmann and H. Theissing. *Zeits. f. Physik*, 52. 7–8. *pp.* 453–463, 1928.

Pure molecular hydrogen has no influence on the photoelectric sensitivity of potassium. There is similarly no change when hydrogen and potassium are brought into closer contact by adsorption on platinum black. The selective maximum of potassium is only developed in the presence of H^+ ions. It is suggested that these ions are adsorbed on the metal surface to form a species of chemical compound. F. J. W.

1655. Short Undamped Electric Waves. K. Kohl. *Zeits. f. techn. Physik*, 9. 12. *pp.* 472–475, 1928. *Paper read before the Deut. Naturforscher u. Ärzte, Hamburg, Sept.*, 1928.

Experiments on the generation of very short waves by means of valves gave results which are explained by variations of the dielectric constant of the "electron gases" in the condenser constituted by the grid and anode of the valve. A. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1656. Tables of Constants: Electricity, Magnetism and Electrochemistry. R. Audubert, C. de Massacré, A. Buffat, L. Durand and G. Foex. *Tables Annuelles de Constantes et Données Numériques, Paris*, 6. *pp.* 681–777 *and* 1092–1168, 1928. *Part of Volume* 6 (1923–1924).

Under the three main divisions of these tables are included the following sub-sections:

A. *Electricity.*—(1) Electric conductivity of metals, alloys, metallic compounds and various substances. (2) Dielectric constants of certain elements, inorganic compounds, organic compounds and various substances. (3) Thermoelectric forces. (4) Electric arc and high-frequency discharges. (5) Electrical engineering, including (*a*) apparatus, (*b*) conductors, and (*c*) machines.

B. *Magnetism.*—(1) Pure metals. (2) Steels and alloys. (3) Permanent magnets. (4) Effects of time on magnetisation. (5) Magnetostriction and the influence of magnetisation on electrical properties. (6) Para- and diamagnetism. (7) Atomic moments. (8) Magnetochemistry. (9) Magneto-optics. (10) Hall effect.

C. *Electrochemistry.*—I. Conductivity of electrolytes: (1) Conductivities of aqueous solutions, including (*a*) acids and gases and (*b*) aqueous solutions of salts; (2) conductivity of electrolytes in solvents other than water—inorganic and organic; (3) conductivities in mixtures of solvents; (4) mixtures of electrolytes in different solvents; (5) mixtures of electrolytes and of non-electrolytes in different solvents; (6) specific conductivities of pure liquids, of mixtures, and of solutions of non-electrolytes; (7) conductivities of melted salts and of solid solutions; (8) ionic conductivities (mobility of ions); (9) transport numbers; (10) electrolytic dissociation. II. Electromotive forces: (1) Batteries and accumulators; (2) Contact potential; (3) tension of decomposition; (4) supertension; (5) reduction potential; (6) electrometric titration.

References are given to the papers in which the determinations are given. J. J. S.

1657. Distribution of Electricity in Conductors Immersed in a Homogeneous Anisotropic Medium. B. Rossi. *Accad. Lincei, Atti*, 8. *pp*. 223–228, *Sept*., 1928.

The author has previously shown that the distribution of electricity on the surface of a conducting ellipsoid immersed in a homogeneous anisotropic indefinite dielectric is independent of the dielectric homography of the medium and coincides with that presented when the medium is isotropic. The present research is to find whether this property is characteristic of ellipsoids or is common to conductors of various forms. The former is found to be the case. A. D.

1658. Contact Resistance. R. Holm. *Zeits. f. techn. Physik*, 9. 11. *pp*. 454–457, 1928. *Paper read before the Deut. Naturforscher u. Ärzte, Hamburg, Sept*., 1928.

The author distinguishes between surfaces which give metallic conduction and those in which contact is made only at a number of points. From an analogy with thermal conduction the resistance is stated in the equations $t + t^2a/2 = \lambda V^2/8k$ and $R_t = R_0(1 + 2at/3)$, where t is the temperature of the surface, R the contact resistance, V the contact potential difference, λ and k the electrical and thermal conductivities at room-temperature and a the temperature coefficient of the specific resistance. Diagrams illustrate the connection betweem log R_t and log V. The curve departs from theory near the recrystallisation temperature of the surface. Characteristic curves are shown for Au, Ag, Ni graphite and charcoal.

R. S. R.

1659. Effect of a Magnetic Field on the Electrical Resistance of a Contact. J. Cayrel. *Comptes Rendus*, 187. *pp*. 1287–1288, *Dec*. 26, 1928.

Conducting contacts were submitted to a magnetic field of about 20,000 gauss (lines of current perpendicular to the field). For the contacts galena-silver, galena-bismuth, iron pyrites-silver, iron pyrites-bismuth, any change of resistance that may have occurred was such that $(\Delta R/R) < (1/1000)$. For bismuth-bismuth contacts a positive effect was obtained, $\Delta R/R$ equalling $0{\cdot}101$ for $R = 9{\cdot}90\ \omega$. Higher resistance contacts gave smaller values of $\Delta R/R$. W. S. S.

1660. Initial Conductivity of Gypsum and Rock-Salt. N. A. Salessky. *Zeits. f. Physik*, 52. 9–10. *pp*. 695–707, 1928.

Previous work by Tank on glass and by Goldhammer [see Abstract 1700 (1928)] on quartz gave results which led the present author to investigate the initial conductivities of gypsum and rock-salt. The latter were determined at intervals of 0·01 to 0·06 sec. after application of the voltage, and the impossibility of extrapolation was established. Ohm's law was found true for both substances, whilst the validity of the superposition principle was established for the zone of the initial current, as also the failure of previous current history to influence the conductivity. The temperature dependence of gypsum is probably expressed by the usual exponential function, whilst that of rock-salt depends on the time periods through which the measurements are performed. H. H. Ho.

1661. Initial Currents in Quartz. A. D. Goldhammer. *Zeits. f. Physik*, 52. 9–10. *pp*. 708–725, 1928.

Previous work [see Abstract 1700 (1928)] is now continued and the initial currents in two quartz preparations investigated by means of a photographic method. It is found that the time dependence of the initial current in quartz during the first 4 to 17 × 10^{-2} sec. is given by the formula $i = at^{-n}$, but that later the current falls more rapidly than this formula indicates. The voltage-current dependence curve is not a straight line for quartz, and the curvature sign changes according to the intervals through which the measurements are taken. The superposition principle is not obeyed for initial currents, and the cause of this phenomenon is ascribed to the influence of current passage on the conductivity of the quartz, which appears to lower the conductivity in the direction of the current and increase it in the opposite direction. After a period during which the crystal is earthed, the unipolarity of the conductivity changes its sign. A possible explanation of all these phenomena is given by the author. H. H. Ho.

1662. Measurements with the Aid of Liquid Helium. Part III. Resistance of Metals. Explanation of the High Conductivity of Tantalum. Specific Heat of Gaseous Helium. W. Meissner. *Phys. Zeits.* 29. *pp.* 897–904, *Dec.* 1, 1928. *Paper read before the Deut. Naturforscher u. Ärzte, Hamburg, Sept.,* 1928.

The electrical resistance of aluminium, a series of different iron samples, beryllium, cobalt, molybdenum, rhodium, palladium, tantalum, tungsten, iridium, antimony, new silver and carbon was investigated by means of the low-temperature apparatus at the Reichanstalt. The metals were obtained in as pure a condition as possible and were in the form of wires. Readings of the resistance were taken at all temperatures down to 1·32° K., from 273° K., and the results are incorporated in a series of tables. In the case of tantalum the resistance at 4·2° abs. is only 5 × 10^{-8} times that of the resistance at 0° C. A possible explanation is given. Experimental details are set out fully. A new form of calorimeter is described, which was used for the specific heat determinations. It was found that the molecular heat of helium at constant volume and an atmospheric pressure of 0·75, whereby the density was about 1/10 of that of liquid helium, was 1·94 at 5·5° K., *i.e.*, about 65 % of the classical normal value 2·98. The discrepancy from the classical value is explained by reference to the quantum effect. S. G. B.

1663. Alteration in Resistance due to Stretching of Nickel Wires. J. B. Seth and C. Anand. *Phys. Zeits.* 29. *pp.* 951–952, *Dec.* 15, 1928.

Studies the already known unusual behaviour of nickel wire, which at first diminishes in resistance as the stretching load is applied and then increases for increased loads like other metals. Curves have been obtained for loads which increased step by step to a maximum and then diminished again. The ascending and descending branches did not coincide. In several cases one curve crossed the other once or more, forming loops. The form of the curve depended on the previous history of the wire. H. N. A.

1664. Resistance and Thermoelectric Phenomena in Metal Crystals. P. W. Bridgman. *Nat. Acad. Sci., Proc.* 14. *pp.* 943–946, *Dec.,* 1928.

A further discussion of the thermoelectric behaviour of metal crystals [see Abstract 1712 (1928)], taking into account the transverse thermal effect. An improved method of making single metal crystals has been developed, by which it is possible to cast from the same melt a number of single crystals of a wide range of orientation. The thermal e.m.f. between 20° and 88° of single crystals of Zn, Cd, Sb, Sn and Bi against Cu has been measured, and from the results the thermal e.m.f., the Peltier heat, and the difference of the Thomson heat between rods of the same metal in different orientations are calculated. The failure of the Kelvin-Voigt symmetry law is due to the Peltier heat, as distinguished by the Thomson heat. E. E. F. d'A.

1665. Hall Effect and other Properties of the Copper-Antimony Series of Alloys. E. Stephens and E. J. Evans. *Phil. Mag.* 7. *pp.* 161–176, *Jan.*, 1929.

The electrical resistivity, temperature coefficient of resistance, thermoelectric power, Hall effect, specific heat, and density of the copper-antimony series of alloys have been determined. The alloys were chill-cast in the form of plates, and the electrical resistivity and thermoelectric power were determined in this state. The resistivity and thermoelectric power were redetermined after the alloys were annealed at suitable temperatures, and the process of annealing was continued until the values of these electrical properties showed no further variation, the other data being then determined for the alloys in this final state. Singular points corresponding to both Cu_2Sb and Cu_3Sb were obtained in each of the curves showing the relation between electrical resistivity, thermoelectric power, Hall effect, specific heat, density and the concentration of one metal in the alloy. No singular point and no evidence of the formation of compounds corresponding to Cu_2Sb and Cu_3Sb are obtained from the curve connecting the temperature coefficient of resistance and the percentage of antimony in the alloy. Annealing affected the electrical properties of the alloys to a degree depending upon their composition. Whereas the electrical properties of Cu_3Sb were greatly modified by annealing, those of Cu_2Sb remained practically unchanged. H. H. Ho.

1666. Dipole Moments of Certain Aliphatic Ketones. K. L. Wolf and E. Lederle. *Phys. Zeits.* 29. *pp.* 948–950, *Dec.* 15, 1928.

The molecular polarisation of the dissolved dipole substances was extrapolated to infinite dilution; dielectric constants were determined by a method similar to that of Lautsch. The method of obtaining the dipole moment is described, and the results for ten ketones dissolved in benzene are tabulated; the values of the dipole moments lie between $2 \cdot 69 \times 10^{-18}$ and $2 \cdot 79 \times 10^{-18}$, so that it appears that the moments of the ketones are independent of the length and structure of the saturated hydrocarbon chains, the mean value being $(2 \cdot 75 \pm 0 \cdot 05) \times 10^{-18}$. It can be assumed that the moment depends on the CO group, perhaps with the next C octet; it is essentially larger than that of CO$(0 \cdot 108 \times 10^{-18})$. Suggestions are made as to the electronic arrangement in CO and in the ketones. Criticisms by Estermann of the method employed are replied to. H. N. A.

1667. Capacity Measurement by Means of Piezoelectric Oscillators and Resonators. G. A. Kjandsky. *Zeits. f. Physik*, 52. 9–10. *pp.* 743–745, 1928.

Describes two substitution methods, in which quartz is used either as a piezoelectric oscillator or resonator. In the first, a beat method, the frequency of a valve oscillator is balanced against that of a piezoelectric oscillator by means of a variable condenser. The capacity to be measured is connected across the variable condenser and balance again obtained. The difference in the two readings of the variable capacity is the value of the unknown capacity. Low capacities can also be measured by this means. In the second method the luminous quartz resonator of Giebe and Scheibe [see Abstract 1906 (1926)], is coupled to a valve oscillator, and measurement of the unknown capacity is again obtained by shunting it across the variable condenser. R. C. F.

1668. Fournier Photoelectric Cell. R. Dubois. *J. de Physique et le Radium*, 9. *pp.* 310–336, *Oct.*, 1928.

This cell consists of a quartz disc supporting a thin layer of sulphides. Contact is made by means of electrodes of pure lead, and the whole cell is enclosed in a vacuum. The response extends from $0\cdot5\mu$ to 1.3μ. Supersonic frequencies can be detected with the cell, which is of the resistance type. The author investigates the effect of continuous and alternating potentials, and remarks that the use of the latter has the effect of reducing photoelectric fatigue due to the accumulation of positive ions. The main effect is due to the instantaneous liberation of electrons, which form an atmosphere about the elementary crystals. E. E. F. d'A.

1669. Theory of Oscillographs and Indicating Apparatus. A. Blondel. *Comptes Rendus*, 187. *pp.* 921–923, *Nov.* 19, 1928.

Brief comments on the paper by Bogoliouboff and Kryloff [see next Abstract]. A. B. W.

1670. Mathematical Theory of Oscillographs. N. Bogoliouboff and N. Kryloff. *Comptes Rendus*, 187. *pp.* 938–940, *Nov.* 19, 1928.

A short theoretical note elaborating the ordinary theory of oscillographs. A. B. W.

1671. Electrical Charging of Glass by Kathode Rays and its Practical Application. P. Selényi. *Zeits. f. techn. Physik*, 9. 11. *pp.* 451–454, 1928. *Paper read before the Deut. Naturforscher u. Ärzte, Hamburg, Sept.*, 1928.

The author describes two forms of kathode-ray tubes, in one of which a strong field accelerates the electrons to the neighbourhood of the collecting surface while removing the positive ions, and in the other no accelerating field exists. As before [see Abstract 1979 (1928)], sulphur dust is scattered over the electrified glass surfaces to indicate the figures obtained. Illustrations are given of some of the figures. A rate of writing of 4×10^3 cm./sec. is obtained with a kathode-ray intensity of 2μA, and the rate increases proportionately with the intensity of the radiation. Possible uses for picture telegraphy are mentioned. R. S. R.

ALTERNATING CURRENTS AND MAGNETISM.

1672. Influence of Granular Dimensions on Magnetic Properties. O. v. Auwers. *Zeits. f. techn. Physik*, 9. 12. *pp.* 475–478, 1928. *Paper read before the Deut. Naturforscher, u. Ärzte, Hamburg, Sept.*, 1928.

The relationship between granular size and magnetic properties is newly investigated, and experiments on pure electrolytic samples were conducted, the previous thermal and chemical treatment of which was known. The samples were so chosen that on recrystallisation different granular sizes were produced. The mechanical influence of such previous treatments was eliminated by heating the samples to glowing *in vacuo* for 40 hours, after which the magnetic measurements were made. Saturation values, remanence and coercive force were determined for each specimen. It was found that the watt loss diminished roughly according to the cube root of the granular dimensions, but that this relationship was strongly influenced by previous treatment. If kept glowing in an atmosphere of hydrogen the influence of granular size is diminished strongly, whilst similar treatment in a partial vacuum or with a small proportion of oxygen the properties are again considerably changed. The above mathematical relationship has therefore no general application, but the effect depends largely on the chemical constitution in relation to oxygen and carbon content, and varies also with choice of atmosphere. It was also established that the influence of the different atmospheres was considerably enhanced with the increase in the number of grains. It is, therefore, concluded that we have mainly to deal with a surface reaction of the gas dependent on the shape and size of the grains, and that in reality the granular size is a secondary matter in so far as the dimensions influence the variation of the distribution or proportion of deleterious oxide or carbide present. From the point of pure surface area and taking the granular size alone, apart from previous treatment or purity, it is concluded that there is little noteworthy influence on the magnetic properties. S. G. B.

1673. Magnetostriction. L. W. McKeehan. *Zeits. f. Physik,* 52. 9–10. *pp.* 752–754, 1928.

Discusses the results obtained by Schulze [see Abstract 306 (1929)], and shows that these results, instead of disproving the present author's previous results, as Schulze stated, tend rather to confirm them. R. C. F.

1674. Degenerescence of Paramagnetism at High Temperatures. A. Schidlof. *Helv. Phys. Acta,* 1. 9. *pp.* 578–600, 1928. *In French.*

Starting from a simple hypothesis regarding the movement of the electrons of a paramagnetic element, which involves Larmor's principle of precession and the hypothesis of quantic degenerescence, the author obtains a theory which satisfactorily accounts for the experimental laws of paramagnetism up to the point at which ferromagnetic phenomena appear (Curie's point). He arrives at an interpretation of corresponding magnetic states, of the law of Curie-Weiss, and a quantic definition of Curie's point, where the paramagnetic susceptibility is zero. The theory gives acceptable values for the radii of electronic trajectories. E. E. F. d'A.

1675. Theory of Magnetism at Low Temperatures. A. Schidlof. *Helv. Phys. Acta,* 1. 9. *pp.* 601–612, 1928. *In German.*

The considerations advanced [see preceding Abstract] are applied to temperatures below the Curie point. At low temperatures magnetisation and magnetic susceptibility tend to become independent of the temperature, in agreement with the theory of paramagnetism put forward by W. Pauli, Jr. In very intense fields magnetic saturation is obtained, but its value falls below the classical figure. The spontaneous magnetisation of ferromagnetic bodies is not dealt with, but there is reason to believe that the quantum laws come into action here. E. E. F. d'A.

1676. Magnetic Susceptibility of Praseodymium Sulphate. O. Specchia. *N. Cimento,* 5. *pp.* 432–440, *Dec.,* 1928.

Describes a method of measuring the magnetic susceptibility of liquids. Two flat vessels communicate with each other by means of a tube. One of them is placed between the poles of an electromagnet, while the other is shielded. The second vessel is placed in the field of an interferometer. When the magnet is excited a displacement of the liquid results, and the raising of the surface is indicated by the displacement of the fringes. This method is applied to praseodymium sulphate, and the magneton number is deduced from the result. It comes out as 3·58, which agrees well with results obtained by other methods. E. E. F. d'A.

1677. Influence of Temperature on the Susceptibility of Glasses. W. Gerlach and N. Little. *Zeits. f. Physik,* 52. 7–8. *pp.* 464–465, 1928.

The various types of glasses studied have a large temperature coefficient of susceptibility. This is due to the paramagnetic component. F. J. W.

1678. Hughes Induction Balance for Measuring the Susceptibility of Rocks. G. Grenet. *Comptes Rendus,* 187. *pp.* 1134–1136, *Dec.* 10, 1928.

A modified form of Hughes balance is described in which current of about 500 periods from triode valves is used. A telephone in conjunction with a five-stage amplifier is used as detector. With a field of only 20 gauss a coefficient of magnetisation of 5×10^{-6} C.G.S. can be measured in a specimen weighing about 100 gm. Values are given for a number of rocks. F. S.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

1679. Sources of Visible and Infra-Red Radiations for Deep Therapy. M. Luckiesh. *Frank. Inst., J.* 207. *pp.* 79–94, *Jan.,* 1929.

The author points out the general absence of exact physical knowledge as a basis of medical applications of radiation energy. This paper deals chiefly with infra-red radiation, which is applied to induce heat into physiological tissues under the term "deep therapy," which should not be confused with the similar term used in connection with X-ray therapy. The transmission of infra-red radiation *via* different thicknesses of water is discussed, water being considered as analogous to living tissues. Many useful curves are given. Water is stated to be transparent to ultra-violet energy throughout most of the spectral range. In the case of infra-red radiation the transmission of energy from incandescent solids at various temperatures is discussed. Actual measurements show that a tungsten filament at 3500° K. is the best source of radiation, and the use of carbon filament lamps is not advantageous for mechanical reasons. The use of bulbs of varying colour for different treatments is based upon erroneous physical conceptions. The emission of infra-red energy from non-luminous (black-body) objects is also considered, and it is shown that hot-water bottles, hot towels, etc., are more efficient than special apparatus embodying non-luminous radiators. Curves are given for the infra-red transmission *via* glass. Most glasses are transparent to 28,000λ, the transparency decreases beyond 30,000λ, but quite efficient transmission is obtained up to 40,000λ. B. J. L.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

1680. Dependence of Gas Adsorption on Temperature. H. Zeise. *Zeits. f. phys. Chem.* 138. *Abt. A.* 5. *pp.* 289–299, *Dec.*, 1928.

On the basis of the experimental data previously given [see Abstract 319 (1929)] and of those of Homfray, Titoff, and Richardson (*loc. cit.*), it is shown that the coefficients c_1 and c_2 of Langmuir's isotherm equation, $x = \frac{c_1 c_2 p}{1 + c_2 p}$, depend on the absolute temperature in accord with the expressions, $c_1 = a_1 - b_1 T$ and $c_2 = \frac{10^{a_2}}{T^{b_2}}$. The manner in which the maximum number of adsorbed molecules per sq. cm. and the relative period of attachment σ of the adsorbed molecules vary with the temperature is also investigated. The relationship between c_1 and T indicates the existence of a critical adsorption temperature $T_1 = \frac{a_1}{b_1}$, above which no pressure is able to cause adsorption. T. H. P.

1681. Adsorption of the Fluoride Ion. B. Tamamushi. *Kolloid Zeits.* 47. *pp.* 58–60, *Jan.*, 1929.

The fluoride ion, in spite of the fact that it is hydrated to a greater extent than the chloride ion, is also more strongly adsorbed on blood charcoal [see Abstract 1562 (1927)]. This is not due to impurity in the charcoal, since the same results are obtained with the purest sugar charcoal. It is suggested that a complete explanation is afforded if it is assumed that hydrolytic adsorption of fluorides occurs. In support of this suggestion it is shown that from aqueous solutions of hydrofluoric acid the fluoride ion is adsorbed two or three times more strongly than the chloride ion from similar solutions of hydrochloric acid. F. J. W.

1682. Optical Study of Adsorbed Films. J. H. Frazer. *Phys. Rev*, 33. *pp.* 97–104, *Jan.*, 1929.

The optical method of Rayleigh and Drude for the study of surface "transition layers" (Uebergangsschichten) has been experimentally modified so as to give greater accuracy, and has been applied to the study of adsorption on glass. Various substances were investigated, and of these only two, water and methyl alcohol, showed definite adsorption. Curves for these, plotting thickness of adsorbed layer against partial pressure, are given. Up to 5 or 6 mm. pressure there is no detectable adsorption of water vapour (apart from the probable presence of the first monomolecular layer). From then on there is a cluster formation which results in a gradual covering of the surface until at 12·5 mm. pressure there is another monomolecular layer present. Above 13 mm. there is strong condensation. The results for methyl alcohol were similar. Adsorption began at 30 % saturation and continued linearly up to 90 % saturation pressure, when strong condensation set in. It is pointed out that the method is applicable to the study of surface conditions at the interface between any two phases. AUTHOR.

1683. Adsorption Phenomena in Solutions. M. Dubinin. *Zeits. f. phys. Chem.* 140. *Abt. A.* 1–2. *pp.* 81–88, *Jan.*, 1929.

The various adsorption relationships of activated carbon are determined by the formation of different modifications of carbon. The activation of sugar charcoal at 600° to 800° leads to the formation of two types of carbon having different adsorption properties. The carbon obtained by heating to 550° gives a convergent series for inorganic acids and an adsorption series for aliphatic acids corresponding to the Traube rule. On the other hand the 800° activated carbon gives a rising series. Both types of carbon, if free from carbon dioxide, are incapable of adsorbing alkali. By the careful glowing of raw wood charcoal it is possible to obtain an active charcoal corresponding to the crystalline modification. J. K.

1684. Area of Internal Surface of Charcoal as Determined by Adsorption of Normal Aliphatic Alcohols from Aqueous Solution. W. E. Garner and F. E. T. Kingman. *Faraday Soc., Trans.* 25. *pp.* 24–29, *Jan.*, 1929.

The adsorption isotherms of butyl alcohol on charcoal were measured by means of a Zeiss interferometer. The alcohol was dissolved in water to a concentration of 3·6 %, and this solution was further diluted and used for the determinations. The charcoal was carefully purified by treatment with acids and washing with water, to remove soluble matter, heated *in vacuo* and finally washed and dried. The effect of cleaning the charcoal by evacuation and admission of air at high temperatures was studied. A photomicrograph of the structure of charcoal is given.

F. J. B.

1685. Kinetic Theory of Absorption. T. Peczalski. *Comptes Rendus*, 187. *pp.* 1035–1037, *Dec.* 3, 1928.

A dissertation on the absorption of gas by a porous substance. It is shown that if r is the radius of a cylindrical tube plunged in the gas whose molecular mean free path is l_0, then

$$p = p_0 \frac{l_0}{4r\left(1 - \frac{r}{l_0}\right)},$$

where p_0 is the pressure of the gas surrounding the tube, and p the pressure in the tube.

Effect of temperature.—Suppose that the mean velocity, u, of the molecules is very great, then the entry of the gas into the tube is accelerated. The rise in temperature due to adiabatic compression of a perfect gas is given by $T/T_0 = (p/p_0)^{\frac{\gamma - 1}{\gamma}}$, where γ = ratio of specific heats. Hence, substituting from above:

$$\frac{T}{T_0} = \leq \left[\frac{l_0}{4r\left(1 - \frac{r}{l_0}\right)}\right]^{\frac{\gamma - 1}{\gamma}}.$$

In the case of a mixture of gases, that with the greatest mean free path is absorbed the most easily. Lowering the temperature reverses the procedure. The theory is extended to explain the action of salts on metals.

S. G. B.

1686. Absorption Velocity of Gases by Liquids. Part I. Absorption of Carbon Dioxide by Potassium Hydroxide Solution. S. Hatta. *Tohoku Univ., Technol. Reports*, 8. *No.* 1. *pp.* 1–25, 1928. *In English.*

A theoretical and experimental investigation of the absorption by

KOH solution of CO_2 mixed with air. From a consideration of the diffusion velocity of the reactants through the double film at the gas/liquid interface and of the velocity of the chemical reaction, two equations are derived for the rate of absorption:

$$dW/Ad\theta = k_g P_g \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad A,$$

$$dW/Ad\theta = (\tfrac{1}{2}sx + HP_g)/(1/k_l + H/k_g) \quad \ldots\ldots \quad B,$$

where dW is the number of mols CO_2 absorbed in $d\theta$ hours, A the contact area in sq. dm., P_g the partial pressure of CO_2 in atmospheres, H Henry's solubility coefficient of CO_2 in mols per atmosphere, x the concentration of residual free KOH in terms of normality of solution, s the ratio of diffusion constants of CO_3'' and CO_2 in the liquid. $k_g = D_g/t_g$ and $k_l = D_l/t_l$ where D_g and D_l are the diffusion coefficients of CO_2 in air and liquid respectively, and t_g and t_l the thicknesses of the interfacial gas and liquid films respectively. The absorption velocity is given by equation A so long as the residual free KOH concentration x exceeds the critical value $x_1 = 2k_g P_g/sk_l$. Within this range the absorption velocity is constant. When x falls below the critical value the absorption velocity follows equation B, decreasing in linear proportion to the residual free KOH concentration. Experimental results confirm the theory except in the relation between k_l and P_g. k_g increases as the fourth power of the temperature, and k_l as the fifth power. A. J. M.

1687. Solubility in Mixed Solvents. Part II. Solubility of a Substance Miscible in all Proportions with one of the Solvents. E. Angelescu. *Zeits. f. phys. Chem.* 138. *Abt. A.* 5. *pp.* 300–310, *Dec.*, 1928.

It has been shown by Angelescu and Dumitrescu (*ibid.*, 132. *p.* 217, 1928) that the solubility of picric acid in a mixture of two solvents may be calculated by means of the expression, $S_c - S_0 = K.C^p$, where S_c represents the solubility in 100 gm. of the one solvent in presence of C gm. of the other, S_0 the solubility in 100 gm. of the pure solvent, and K and p are constants. This equation is applicable over a large range of concentration for any form of solubility curve. Results are now given for the solubility of phenol in mixtures of water with the different dihydroxybenzenes, with which phenol is miscible in all proportions. In these cases also the above formula is obeyed. T. H. P.

1688. Solubility. Regular Solutions. J. H. Hildebrand. *Am. Chem. Soc., J.* 51. *pp.* 66–80, *Jan.*, 1929.

Regular solutions are defined as those solutions of a common solute in various solvents which give families of solubility curves, and from which chemical effects and associations changes are absent. They are solutions in which no change of entropy, except for the small entropy of expansion, is involved in the transfer of a constituent from it to an ideal solution of the same concentration. The theory was developed, and an equation given by van Laar upon the basis of the van der Waals equation of state, and which was recently derived by Heitler from different assumptions, was applied to a number of solutions with satisfactory results. The equation was applied to the calculation of other properties which depend upon activity, including the e.m.f. of concentration cells, the heat of solution of solids, the expansion on mixing, and the Gibbs adsorption equation. F. J B.

1689. Solubility of Calcium Hydroxide. J. B. Miller and J. C. Witt. *J. Phys. Chem.* 37. *pp.* 285–289, *Feb.*, 1929.

The solubility of calcium hydroxide in water as exhibited by freshly hydrated calcium oxide has been made the subject of a detailed study. The progress towards equilibrium of the system consisting of an excess of freshly hydrated calcium oxide and water was followed closely by means of the electrical conductivity of the solution. Values for the solubility of calcium hydroxide and for the conductivity of the saturated solution are given.

1690. Determination of Concentration Gradients by means of Refracted Light Rays. O. Lamm. *Zeits. f. phys. Chem.* 138. *Abt. A.* 5. *pp.* 313–331, *Dec.*, 1928.

In this paper a new but simple photographic method of observation is described for the determination of concentration gradients by means of the refraction of light rays. By its means the theory of the beam path in a diffusion layer is extended, the refractive power of a diffusion layer is calculated, and the theory of the method elaborated. A diffusion experiment with cane-sugar is described which establishes the utility of the method for exact determinations of the concentration distribution at any instant. H. H. Ho.

1691. Binary Solutions of Consolute Liquids. W. D. Bancroft and H. L. Davis. *Nat. Acad. Sci., Proc.* 15. *pp.* 8–10, *Jan.*, 1929.

The authors have found empirically that the behaviour of pairs of solutions can be represented with unexpected accuracy by the equation: $\left(\frac{b_1/M_1}{b_2/M_2}\right)^a = \left(\frac{N_1}{N_2}\right)^a = K\frac{p_2 - p_2'}{p_2'}$ where M_1 and M_2 are the gramme-molecular weights of the two components in the vapour, while a and K are empirical constants obtained at present from the experimental data. If a and K are each unity, the equation becomes identical with that of Raoult, $N_1/(N_1 + N_2) = (p_2 - p_2')/p_2$, which is thus a special case. Data are given for ethyl alcohol and water and for acetone and ethyl ether. H. H. Ho.

1692. Free and Bound Liquids in Gels. W. B. Hardy. *Kolloid Zeits.* 46. *pp.* 268–277, *Dec.*, 1928.

The author cannot conceive that the solvent carried by a dissolved molecule, charged or uncharged, can have a definite surface beyond which the attraction of the molecule should suddenly stop. Even if cohesion and the attraction by the molecule should have a small range of about 10^{-8} cm., there must be an influence extending farther out and depending upon temperature. In a solution, in which a crystal is growing, there is a crystallisation pressure increasing with falling temperature, which drives liquid molecules into the lattice. In a freezing gel part of the water passes into the ice phase [see Moran and Hardy, Abstracts 231 and 232 (1927)], but only up to a certain limit; part of the water does not freeze even in liquid air. Moran concluded that 1 gm. of gelatine could adsorb 0·539 gm. of water but the freezing may be prevented by the increasing frictional resistance to the change water-ice [Hardy and Nottage, Abstract 1444 (1928)]. When a thin layer of lubricant between a cylinder and a plate is broken by tensile stress, the layer is found to consist of an adsorption layer on each surface and an intermediate layer of crystals.

Fracture takes place at the interfaces of these layers, and when the system is not symmetrical (a copper cylinder on a steel plate), the fracture is near the copper and may be up to 6μ from the steel; the adhesion force is then the mean between the values for copper and steel, and its range is extraordinarily large. The real quantity determined in measurements of the thickness of adsorption layers is the intensity of the disturbing forces, which tend to change the conditions (gas, liquid, crystal) of the molecules or atoms in the layer. Such thickness measurements do not admit of estimating the range of cohesion forces. H. B.

1693. Jellies and Gels. Wo. Ostwald. *Kolloid Zeits.* 46. *pp.* 248–267, *Dec.*, 1928.

A general review. A sharp distinction between jellies and gels is hardly possible in the cases of vitreoids (undercooled, glassy melts), resinoids, highly-disperse alloys, magmoids (pasty muds), and spumoids, and classification is difficult. The new scheme of classification proposed is based on the genetic principle, and distinguishes jellies produced by desolution (lowering of the solubility), by coagulation, chemical reactions, and swelling, and fermentogenous, bacteriogenous, cryogenous and geological jellies. Immobilisation and gelatinisation are characterised by cessation of the Brownian movements, emulsoid or suspensoid (crystalline) demixing of liquid-liquid systems and floculation, and development of secondary structures and lyoadsorption. The formation of structural elements is the only known ultramicroscopic criterion of a jelly. Swelling depends upon several factors and is not explicable by one general theory. Experimentally the temperature coefficient of swelling is positive, whilst thermodynamically it should be negative. There is parallelity between the graphs of the swelling of acetylcellulose in benzene-alcohol mixtures and of Debye's polarisations in these mixtures. H. B.

1694. Thermal, Mechanical and Röntgen-Ray Study of Swelling. R. O. Herzog and K. Weissenberg. *Kolloid Zeits.* 46. *pp.* 277–289, *Dec.*, 1928.

The examination is from both the material and energetic standpoints and aims at connecting the various properties of a system with the type of structure. The considerations are based on thermodynamics, mechanics and molecular kinetics. The heat of swelling is positive and large compared to the heat of dilution, which is small, except when hydrates are formed. The swelling pressure is potential, the osmotic pressure kinetic. Swelling frequently leads to the formation of new substances, which are rarely sufficiently crystalline for Röntgen examination. But it is sometimes possible to test the reversibility of the total volume of the system, as well as that of the macro- and micro-volumes, and of the texture and other variables of the system. The texture is mostly retained when amorphous and crystalline substances (loaded silk, tanning) are deposited in the gel. But there will be a slight distortion sometimes; in mercerisation without stretching, *e.g.*, the fibre is destroyed. The property first observed in caoutchouc, that the stretched gel forms a fibrous texture whilst the unstretched appears to be amorphous, has also been found in gelatine and celluloid. H. B.

1695. Thixotropy. H. Freundlich. *Kolloid Zeits.* 46. *pp.* 289–299, *Dec.*, 1928.

When a 5 % iron-oxide sol, solidified to a pasty gel by the addition of sodium chloride, is shaken, it turns temporarily liquid again, and this reversible isothermal sol-gel change, which Péterfi called thixotropy, may be repeated many times. Many other sols show this property; the recongelation may be almost instantaneous or take days. The presence of electrolytes is not indispensable. But different electrolytes differ as to their effectiveness; the anion is more important than the kation, and H˙ tends to liquefy, whilst OH′ shortens the time required for recongelation after shaking. Too much electrolyte prevents the thixotropy. The Al_2O_3 sol and others are also doubly-refracting when streaming, not when at rest. The presence of metals promotes the recongelation and the double refraction, but the two phenomena do not run parallel. The double refraction (not the thixotropy) requires that the colloid particles are anisotropic and in regular orientation. In streaming doubly-refractive sols the range of the forces, acting across the liquid which separate the colloidal particles, must approach the order 100$\mu\mu$. Quantitative calculations are impossible, as the size of the actual colloidal particle is unknown. An estimate is possible, however, in the natural silicate bentonite, which swells in water (without addition of electrolyte) to a thixotropic paste. The rod-shaped particles of this paste are probably of dimensions 1, 0·1, 0·01μ, and each particle seems to absorb $4\cdot7 \times 10^8$ molecules of water. Protoplasm may be regarded as thixotropic. H. B.

1696. Synaeresis. A. Kuhn. *Kolloid Zeits.* 46. *pp.* 299–314, *Dec.*, 1928.

By synaeresis is understood the property of many gels, silicic acid, dyestuffs, soap, rubber, milk, etc., when ageing, spontaneously to separate out a liquid which may be resorbed after being expressed. Reviewing the literature the author finds great differences, in the behaviour of various materials as to the time after which synaeresis becomes noticeable, concentration, etc. Increased concentration may hasten (silicic and gels) or retard the phenomenon (agar-agar); there is an optimum concentration in the case of viscose. The first effect of rising temperature seems to be dehydration of the gel particles (formation of the xerogel); afterwards more water is bound. The media (water, alcohol, acid, etc.) and additions of particles, pressure, etc., have their influences. The expressed liquid contains the electrolyte and part of the colloid. The phenomena are somewhat analogous to crystallisation and retrograde adsorption and are discussed as combined structural changes and desolvation. H. B.

1697. Optical Determination of the Size of Particles in Suspensions. G. I. Pokrowski. *Kolloid Zeits.* 47. *pp.* 55–58, *Jan.*, 1929.

A method has been developed for the measurement of the size of particles in a suspension which is dependent upon the extent of the scattering of a beam of light incident upon the suspension. F. J. W.

1698. Electrolyte Coagulation of Rod-Shaped Colloids. Parts I and II. G. Wiegner and C. E. Marshall. *Zeits. f. phys. Chem.* 140. *Abt. A.* 1–2. *pp.* 1–63, *Jan.*, 1929.

Part I considers rapid perikinetic coagulation, and a method is described of measuring the coagulation of sols containing rod-shaped ultramicrons in the slit-ultramicroscope according to the directions of Siedentopf and Zsigmondy. In the cases of the sols of vanadium pentoxide and benzopurpurin, which have rod-shaped ultramicrons, the coagulation is quicker than with sols composed of spherical ultramicrons. Benzopurpurin sols possessing approximately spherical ultramicrons exhibit the normal rapid coagulation as found by Smoluchowski. It is shown that this abnormal rapidity depends on the shape of the ultramicrons and not on their chemical nature or on the coagulant used. The greater the ratio of length to thickness the quicker the system will coagulate at the outset, the velocity increasing with the initial number of particles. The polyones formed coagulate slower than the rod-shaped monones, and the velocity approaches the Smoluchowski value for spherical particles. Part II deals with slow perikinetic coagulation, which follows the Smoluchowski laws for benzopurpurin 4B provided the ultramicrons are spherical. Shaking has less influence upon slow than upon rapid coagulation. For typical rod-shaped colloids (*e.g.*, vanadium pentoxide sol), slow coagulation is quicker at the start than in the later periods, and may even have a greater initial velocity than the rapid coagulation of spherical ultramicrons. The transition from rapid to slow coagulation occurs with decreasing quantities of electrolytes, so that the retardation of the coagulation of rods is greater than for spheres. Qualitative and quantitative data for vanadium pentoxide and benzopurpurin are included. H. H. Ho.

1699. Conductance Measurements of Binary Salts in Ethylene Chloride. P. Walden and G. Busch. *Zeits. f. phys. Chem.* 140. *Abt. A.* 1–2. *pp.* 89–123, *Jan.*, 1929.

The measurements are made with the apparatus of Walden and Ulich [*ibid.*, 123, *p.* 455 (1926)] and acetone as solvent, and concern the salts tetraethylammonium picrate at 0°, 25°, 50°, and a large number of similar salts (chloride, perchlorate, iodide, methyl, diethyl compounds, etc.) at 25°. Densities and viscosities η of solvents and salts are also determined. The dilution v goes up to 400,000 l/mol. The square root law of Kohlrausch-Debye-Hückel, $\Lambda_v = \Lambda_\infty - a\sqrt{c}$, is confirmed also for non-aqueous solvents and high dilution. The lower validity limit of this law shifts with decreasing dielectric constant ϵ of the solvent towards higher dilution according to Walden's formula $\epsilon\sqrt[3]{v} = \text{const.}$ The character of the salt is important for the conductance λ_v, and the degree of dissociation $\alpha = \lambda_v/\lambda_\infty$. Although of the same type, the tetra-alkyl compounds (strong salts) differ much from the mono-, di-, trisalts (weak). The dissociation relations are discussed with reference also to solutions in water, alcohols and acetone. The extrapolated λ_∞ is tested as to the additivity of conductance, and Kohlrausch's rule is confirmed also for compounds of high molecular weight. Confirmed is further Walden's rule $\lambda_\infty . \eta = \text{const.}$ for the tetraethylammonium picrate; the value observed, 0·563, agrees with the values found in the solvents water, ethyl and methyl alcohol and acetone. Starting from this product the mobilities of the kations and anions are deduced. H. B.

1700. Relative Frequency of Occurrence of Zirconium and Hafnium, and Niobium and Tantalum. G. v. Hevesy and K. Würstlin. *Zeits. f. phys. Chem.* 139. *pp.* 605–614, *Dec.*, 1928.

No mineral is known in which hafnium is the chief metallic constituent, and the hafnium content is always smaller than the zirconium content. X-ray spectrographic analysis of 16 hafnium-bearing minerals gives values for the ratio $HfO_2/(ZrO_2 + HfO_2)$ varying from 0·0024 to 0·22, the average being 0·020. In view of the close chemical relationship

between zirconium and hafnium it is unlikely that preferential removal of one of these from the silicate crust has occurred. The above ratio in these minerals is, therefore, closely related to the relative frequency of occurrence in the solar system, and ultimately to the relative stability of the atom cores. In the case of niobium and tantalum, in some minerals one of these elements preponderates, and in some the other. For this reason, and on account of the less marked chemical similarity of niobium and tantalum, the latter element differs from hafnium in forming characteristic minerals. In this connection V. M. Goldschmidt's conception of " geochemical camouflage " [*Naturwiss.* 14. 295, 1926] is discussed.
A. J. M.

1701. Critical Points of Pure Carbon Steels. T. Sato. *Tohoku Univ., Technol. Reports* 8. *No.* 1. *pp.* 27–52, 1928. *In English.*

In pure iron and carbon steels the degree of superheating and supercooling of the critical changes (observed by dilatometric and magnetic methods) varies with the rate of heating or cooling. The tendency to superheating and supercooling of the A_3 change increases as the carbon content increases up to 0·85 %. The temperature at which deposition of cementite from austenite begins in hyper-eutectoid steels is depressed to a considerable extent by rapid cooling, but rapid rates of heating cause little superheating of the converse change. Very marked supercooling of the A_1 change can occur in low carbon steels, but the degree of superheating of this change varies only slightly with the carbon content. The data obtained with various rates of heating and cooling are extrapolated to zero rate of change of temperature in order to construct an equilibrium diagram for the iron-cementite system in the solid state. Under true equilibrium conditions the A_1 change occurs at 726° C. A. J. M.

1702. Equilibrium Diagram of the Iron-Sulphide and Manganese-Sulphide System. Z. Shibata. *Tohoku Univ., Technol. Reports* 7. 4. *pp.* 39–47, 1928. *In English.*

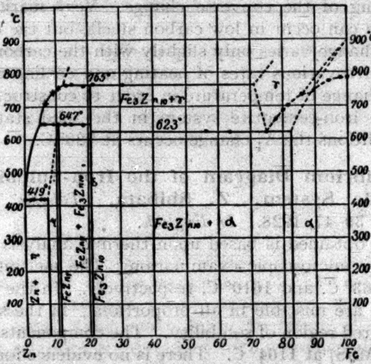
The diagram obtained is based upon thermal analysis and the results are confirmed by microscopic examination. The melting points of FeS and MnS are 1163° C. and 1610° C. respectively. In the liquid state the two components are miscible in all proportions; in the solid state there is for each a limited region of solubility. The components form a eutectic (with 6·5 % of MnS) at 1164° C. There is no evidence for any compound such as $Fe_3Mn_2S_5$. The solubilities of the α and β solid solutions change with temperature. The former dissolves 2 % of MnS at the eutectic temperature, but scarcely any at room-temperature, and the latter dissolves 75 % of FeS at the eutectic temperature and 24 % at room-temperature.
A. A. D.

1703. X-Ray Investigation of Age-Hardening in Beryllium-Copper Alloys. O. Dahl, E. Holm and G. Masing. *Zeits. f. Metallkunde,* 20. *pp.* 431–433, *Dec.,* 1928.

On cooling a supersaturated α solid solution of beryllium in copper, precipitation of the γ constituent occurs. The α solid solution crystallises on a face-centred cubic space-lattice, the γ constituent on a body-centred cubic lattice. The X-ray spectrogram (Debye Scherrer) of an alloy containing 2·5 % beryllium, quenched from 800° C., shows only the lines of the α solid solution. On ageing the alloy at 150° C. no lines characteristic of the γ-lattice appear, even after 243 hours' treatment, but the lines of the α-lattice become perceptibly diffuse after 4 hours. At 200° C. the blurring of the α-lines occurs more rapidly, but no γ-lines are visible after 7 hours' ageing at this temperature. Weak reflections from the 100 and 200 planes of the γ-lattice are observed as diffuse lines after ageing for 81 hours at 250° C. At 350° C. the lines of the γ-lattice are present even after 10 minutes' ageing, their number and intensity increasing with the duration of treatment. The diffuse character of the lines of the α-lattice in the early stages of ageing is to be attributed to high internal stresses, while that of the lines of the γ-lattice is due to the high degree of dispersion of this constituent. On prolonged ageing the lines gradually become sharper, more rapidly in the γ-reflexions than in those from the α-lattice. Cold-working the wire after quenching accelerates enormously the ageing process on subsequent heat-treatment. A. J. M.

1704. Iron-Zinc Equilibrium Diagram. Y. Ogawa and T. Murakami. *Tohoku Univ., Technol. Reports* 8. *No.* 1. *pp.* 53–69, 1928. *In English.*

Thermal analysis, microscopic examination and measurement of physical properties are employed for the investigation of the constitution of iron-zinc alloys. The temperatures of the A_3 and A_2 transformations of iron are lowered by additions of zinc up to 25 %, where a eutectoid decomposition of the γ solid solution occurs at 623° C. The limit of solid solubility of zinc in x-iron is 18 %. Two compounds are recognised: Fe_3Zn_{10}, of very restricted composition, formed at 765° C. by a peritectic reaction between liquid and the γ solid solution, and $FeZn_7$, with a range of solid solubility of 3 %, formed by a peritectic reaction between liquid and Fe_3Zn_{10} at 647° C. The eutectic point of the system coincides with pure zinc, which has no discernible solid solubility for iron. A. J. M.



1705. Changes in Length and Modulus of Elasticity during Ageing of Beryllium-Copper Alloys. O. Dahl and C. Haase. *Zeits. f. Metallkunde*, 20. *pp.* 433–436, *Dec.*, 1928.

On slowly heating a specimen of an alloy of copper containing 2·5 % beryllium, which has been quenched from 800° C., the coefficient of linear expansion remains constant up to 150° C., at which point hardening commences. As the temperature rises further the rate of expansion falls off, becoming constant again at 300° C. Further heating to 500° C.

causes a marked fall of hardness, but the length continues to increase in direct proportion to the temperature. In cooling to room-temperature the coefficient of contraction remains constant. The change of length on ageing, unlike the hardness, is therefore affected only by the mass of material precipitated and not by the form in which it is present. When a quenched specimen of the same alloy is aged at 200° C. or 250° C. the electrical conductivity falls to a minimum value and then increases. At the same time the Brinell hardness and modulus of elasticity rise and the length diminishes. At 400° C. the modulus of elasticity and the conductivity rise simultaneously to constant values, the hardness rising rapidly to a maximum and then decreasing rapidly. The modulus of elasticity, like the length, is a function only of the mass, and not of the form, of the γ-constituent precipitate. Assuming that the changes in length and modulus of elasticity are directly proportional to the mass of γ precipitated, it is possible to estimate from them the extent to which precipitation has occurred after various periods of ageing. At 200° C. the minimum value of electrical conductivity is attained when about 30 % of the ultimate separation of *b* has occurred, and by the time the electrical conductivity of the aged material equals that in the quenched state, 50 % of the γ has already been precipitated. The results show that the precipitation theory accounts for all stages of the ageing process in beryllium-copper alloys. A. J. M.

1706. Tungsten-Carbon System. K. Becker. *Zeits. f. Metallkunde*, 20. *pp.* 437–441, *Dec.*, 1928.

Only two carbides have been established with certainty in the system W–C, *viz.*, WC and W_2C, the latter existing in two allotropic modifications with a transition point at 2400° C. A third carbide, W_3C_2, has been suspected, although not yet identified up to 2600° C. Mixed crystal formation between W and W_2C, WC and W_2C, and WC and C, cannot be röntgenographically established. The transition point of the two W_2C modifications has been fixed by röntgenographic and conductivity measurements [see Abstract 399 (1929)]. Further data are necessary for the correct representation of state of the system, W–C. H. H. Ho.

1707. Supertension of Hydrogen on Alloys. M. G. Raeder and D. Efjestad. *Zeits. f. phys. Chem.* 140. *Abt. A.* 1–2. *pp.* 124–132, *Jan.*, 1929.

Further experiments on the lines previously described [see Abstract 2004 (1928)] with the alloys Pb-Sn (eutectic discontinuous series of mixed crystals), Tl-Pb (peritectic mixed crystals with maximum melting point), Cd-Hg (peritectic mixed crystals), Mg-Sn (compound, two eutectics, no mixed crystals), and also Cu-Sn and Ag-Zn. The former conclusions are mostly confirmed. In mixed crystals the supertension curves may keep uniformly between the curves for the components (Hg-Cd), or may rise steeply above them (Sn-Pb, Cu-Sn, Ag-Zn); an abrupt drop in the curve with incipient alloying has not been observed so far. The formation of neither eutectics (Sn-Pb) nor compounds (Mg-Sn, Ag-Sb) affects the supertension perceptibly; in this last respect the previous and present experiments do not appear to be in accord. H. B.

1708. Transformation Data for Brass containing 57·5 to 63·5 % of Copper from its Mechanical Properties. P. Dejean. *Comptes Rendus*, 188. *pp.* 169–172, *Jan.* 7, 1929.

Transformations produced during the heating or cooling of alloys are found to be very accurately indicated by the anomalous variations of their mechanical properties, of which plasticity has now been studied. A number of cylindrical test pieces of brass containing from 57·5 to 63·5 % of copper have been examined at different temperatures, and the points of inflexion, indicating transformations at 475° and 685°–783°, on the data curves, correspond admirably with results by other methods. H. H. Ho.

1709. Internal Transformations of a Cupro-Aluminium Alloy. A. Roux and J. Cournot. *Comptes Rendus*, 188. *pp*. 172–173, *Jan*. 7, 1929.

Structural transformations in a cupro-aluminium alloy have been studied by the X-ray method previously described [see Abstract 2901 (1928)], and the relationships between two solid solutions and the compound Cu_3Al determined. H. H. Ho.

1710. Activities of Molten Alloys of Thallium with Tin and with Lead. J. H. Hildebrand and J. N. Sharma. *Am. Chem. Soc., J.* 51. *pp*. 462–471, *Feb*., 1929.

The activities of thallium in liquid alloys with tin and with lead are determined over a range of 125° C. by the aid of e.m.f. measurements. For the thallium-tin system the following equation is found applicable: $\log \gamma_1 = \beta N_2^2$, where γ_1 is the activity coefficient of the thallium, N_2 the mole fraction of tin and β_2 a cofficient with the value $1{\cdot}0763 - 0{\cdot}00101T$. The partial molal heat of transfer of thallium from an ideal solution to the tin solution of the same mole fraction is calculated over a range of composition and temperature, and a comparison is made with the free energy values calculated for the same process. The thallium-lead system, although not deviating much from ideality, shows a rather complicated behaviour, almost identical with that of cadmium-bismuth alloys, and which may be attributed, in part, to the presence in solution of some of the compound $PbTl_2$. J. N. P.

1711. Reaction Limits, Peaks of Electric Conductance and Röntgen Interferences of Metallic Mixed Crystals. G. Tammann. *Ann. d. Physik*, 1. 3. *pp*. 309–317, *Feb*. 9, 1929.

When the members of a continuous series of mixed crystals are exposed to the action of a chemical, which only attacks one of the two constituents, crystals containing more than 2/8 or 4/8 of the more noble constituent will not be attacked, but will behave as if they consisted entirely of this constituent. That indicates that, with a normal distribution of the atoms in the lattice, the limit of attack should be sharp. The normal distribution can be tested by X-ray examination and by interferences, due to the lattices containing atoms of both kinds and to partial lattices containing only one kind of atom. But the limits of reactions are not in accord with the peaks of the electric conductance curves which cannot be accepted as safe criteria for compounds. The protective action is only effective at temperatures at which there is no perceptible diffusion, and is not observed in glasses with random molecular distribution. The author also discusses potential curves of various alloys, etc., and particularly the reaction limit for copper-gold alloys with respect to le Blanc and collaborators [see Abstract 3324 (1928)]. H. B.

1712. Gibb's Theorem—Phase Rule—for Heterogeneous Equilibria. V. Polara. *Accad. Lincei, Atti*, 8. *pp*. 500–505, *Nov*. 18, 1928.

A mathematical treatment of this theorem. T. H. P.

1713. Decomposition of Explosives. J. P. Koettnitz. *Zeits. f. Elektrochem.* 34. *pp.* 768–783, *Nov.*, 1928.

By means of the Nernst heat theorem an expression is derived to give the temperatures at which detonation or decomposition of a number of explosive compounds occurs. The general approximate equation used has the form: $\log P = \frac{-Q}{4571T} + n(1{\cdot}75 \log T + C)$, where P is the pressure, Q, the heat of reaction, *n*, the number of molecules or atoms produced by the detonation, and C, the chemical constant. The assumption is made that at the decomposition temperature T, the pressure of the reaction is 1 atmosphere. The chemical constant is evaluated from Trouton's constant or from Nernst's formulæ and has approximately the value 3. Measurements and calculations are made with mercury fulminate, nitrogen sulphide, nitrogen chloride, silver oxalate and acetylide and a number of nitrides, azides and nitro-derivatives. With detonations, if a value is taken for *n* which assumes the products of the reaction to be in the atomic condition, a very close agreement is found between calculated and observed decomposition temperatures. Ammonium nitrate decomposes explosively at a lower rate and the calculation agrees with the assumption that the reaction products are present in the molecular condition. Detonations are accordingly regarded as atomic and explosions as molecular reactions. With the majority of explosives, the temperatures produced by detonation are calculated by means of the Nernst formulæ to range from 3800° C. to 4500° C. and the pressures from 10,000 to 14,000 atmospheres. A hypothesis is put forward according to which detonation reactions may be regarded as electrochemical phenomena, the atoms in the molecules of a detonant forming an electromotive series and constituting an aggregate of condensers, the isolation of which is bridged over by volatilisation through the action of heat or else by impact. The action of anti-detonants is accounted for. The decomposition potentials of these atoms is related to the heat of detonation by means of the Helmholtz-Thomsen rule. J. N. P.

1714. Gaseous Explosive Reaction at Constant Pressure. Effect of Inert Gases. F. W. Stevens. *Am. Chem. Soc., J.* 50. *pp.* 3244–3258, *Dec.*, 1928.

The rate of propagation of flame in gaseous explosive mixtures at constant pressure is measured by holding the mixture temporarily in a soap-film container, igniting by a spark in the centre and recording the time-volume relation of flame propagation photographically on a suitably arranged moving film. Time intervals are recorded simultaneously by a calibrated timing fork. An expanding spherical shell of flame is formed which remains concentric with the point of ignition. The final volume occupied by the equilibrium reaction products corresponds to the equilibrium constant of the reaction. The reaction rate at constant pressure is found to remain constant and to be proportional to the product of the initial concentrations (partial pressures) of these gases, or $S = K_1[A]^{n_1}[B]^{n_2}[C]^{n_3} \ldots$, where S is the linear rate of propagation of the reaction zone measured relative to the active zone it is entering, and K_1 is a proportionality factor. Measurements are made of the influence of the inert gases helium, argon, nitrogen and carbon dioxide on the thermodynamic equilibrium and the propagation of the reaction zone. It is found that this effect on the $CO_2 - O_2$ reaction rate may be expressed by the addition of the term $+ B[G_1]$ to the above equation, where $[G_1]$ represents the initial concentration of the inert gas in the mixture. The values of B for the different gases are of an order roughly paralleling the order of their heat conductivities, but follow also the order of their molecular heats. J. N. P.

1715. Kinetics of the Combustion of Carbon Monoxide. W. Finkelstein and W. Maschowetz. *Zeits. f. phys. Chem.* 138. *Abt. A.* 6. *pp.* 369–378, *Dec.*, 1928.

Results are given of experiments on the kinetics of the combustion of carbon monoxide at 500° in presence of various feeble catalysts. In glass balloons the reaction exhibits a fall in velocity from one experiment to the next, the catalytic activity of the glass walls being poisoned by the carbon dioxide formed. The activity is restored partly by rinsing the vessel with water and wholly by treating it for 20–30 minutes with concentrated nitric acid and then with water. The results are in agreement, as also are those obtained with alumina as catalyst, with a termolecular reaction. The catalytic action of the glass is related to adsorption phenomena. Reaction occurs only when free carbon monoxide molecules impinge on adsorbed and activated oxygen molecules at the surface of the catalyst. Two monoxide molecules must impinge on one such oxygen molecule, since the reaction is of the third order. As the glass contains not only the weak anhydride, silica, but also strong bases, it must possess affinity for the carbon dioxide, which is adsorbed chemically and hence poorly reversibly. Thus the poisoning of the glass surface by carbon dioxide depends on the stability of the adsorbed layer of carbon dioxide in presence of the layers of oxygen and carbon monoxide. T. H. P.

1716. Chemical Reaction in the Interferometer U-Gauge. Oxidation of Phosphorus. C. Barus. *Nat. Acad. Sci., Proc.* 14. *pp.* 939–943, *Dec.*, 1928.

The two closed limbs of the gauge contain shallow pools of mercury and above them air, and communicate each with a Dewar flask of about 450 cm.^{3} Phosphorus is placed in the one flask, which is then closed again, and the temperature- and pressure-rise are observed for about 30 minutes by mercury thermometers in the flask and by the interferometer; there is no further explanation of the method. The curves are peculiar. There will be heat liberation by the oxidation of the phosphorus and by the adsorption of moisture by the P_2O_5 formed. But the oxidation seemed soon to stop owing to an oxide scum forming on the surface, though only 3 % of the oxygen had been absorbed, and there was indication that the oxidising phosphorus exhaled some emanation under loss of heat. H. B.

1717. Action of Light and X-Rays on Ammonium Thiocyanate. C. G. Patten and H. D. Smith. *Roy. Soc. Canada, Trans.* 22. *Sect.* 3. *pp.* 221–224, *May*, 1928.

The bright red colouration of concentrated solutions of NH_4CNS, which is produced by exposure to sunlight, and which rapidly disappears in the dark, is attributed to photochemical action on small traces of iron, present as impurity. Many of the experiments of Holmes [see Abstract 2827 (1926)] can be explained in this way. Light of all wave-lengths less than 5400 Å. is effective in producing the discolouration—4000 to 4300 Å. being apparently the most effective region of the spectrum. Similar effects are found with X-rays. (The possibility of a similar explanation of the colouration of glass by X-rays is being examined by the authors.) The absorption spectra of both clear and coloured solutions have been measured. H. R. R.

1718. Chemical Effects of Kathode Rays on Oxygen, Air, Nitric Oxide and Carbon Dioxide. W. F. Busse and F. Daniels. *Am. Chem. Soc., J.* 50. *pp.* 3271–3286, *Dec.*, 1928.

The rays produced by a Coolidge kathode-ray tube were passed through a nickel window 0·0012 cm. thick, across an air gap and through a window of mica (0·01 mm.) or cellophane or aluminium (0·02 mm. thick) which formed one end of the reaction tube which was 22 or 34 cm. long. So much heat was generated in the nickel window that the current could be turned on only one-fourth the time. Though the maximum range of the kathode rays for 185 kV electrons was about 50 cm., for short exposures there was no detectable difference in yield with tubes of 22 and 34 cm. length. The influence of voltage, space current, time and length of air gap was examined; increase of the last from 0·5 to 2·0 cm. halved the energy crossing. In oxygen the initial rate of production of ozone is multipled by 8·4 when voltage increases from 140 to 200 kV. It is also proportional to the space current. The rate of increase decreases as the period of exposure increases owing to decomposition, attaining a concentration of 0·1 % ozone with a space current of 1 milliampere. In air ozone and nitric oxide are formed simultaneously. Nitric oxide is decomposed into nitrogen and oxygen, the latter combining with excess oxide. The energy of the kathode rays entering the reaction tube varied from 3 to 16 cal./min. The results are summarised in the following table (M = number of molecules acted on; C = average number of electrons crossing the tube, and, therefore, much larger than, though proportional to, the number entering the reaction tube):

Reaction.	Voltage.	Current, mA.	Micro-moles per minute.	M/C.	Cal. per minute.	Cal. per mole $\times 10^{-5}$.
$O_2 \rightarrow O_3$	185	0·4	25	100	8·6	3·4
Air $\rightarrow O_3$	185	0·4	11	44	8·6	7·8
Air $\rightarrow$ NO	185	0·4	4	14	8·6	22
$NO \rightarrow NO_2$	185	0·4	57	230	8·6	1·5
$CO_2 \rightarrow CO$	200	1·0	2	3	37·0	180 Unsatisfactory

The chemical behaviour of high-voltage electrons is thus essentially similar to that of α-particles. The ratio of molecules acted on to pairs of gas ions is in both cases approximately unity. The effects depend on the ionisation potential of the gas and the reactions following ionisation. C. A. S.

1719. Potential Difference at Metal-Air Surfaces. Marie Andauer. *Zeits. f. phys. Chem.* 138. *Abt. A.* 5. *pp.* 357–368, *Dec.*, 1928.

Examination of a number of metals by the method previously described [see Abstract 1949 (1927)] gives results which do not bear out the earlier assumption that the p.d. arising at the contact of metal with air is negligible. The object of the experiments now recorded was to determine the absolute value of at least one metal-air p.d., since it would then be possible to ascertain the corresponding value for any other metal and, by the method described, that of the separate metal-liquid p.d. To ensure the absence of a surface water film, the metal was heated to 180°, the change in p.d. produced by the rise in temperature being determined. The metal-air p.d. for any sample of metal is reproducible, but different values are found for different samples of the same metal and for the same sample submitted to varying treatments. The absolute p.d. between the mercury of the 0·1 normal potassium chloride-calomel electrode and the solution is now found to be $-0{\cdot}26$ volt, which differs by 0·83 volt from the value previously found. According to the new result, the zero point of the absolute potential scale will be in the neighbourhood of $+0{\cdot}597$ volt. T. H. P.

1720. Transference Numbers of Lithium Chloride and Bromide and of Sodium Iodide in Acetone and Alcohol. W. Birkenstock. *Zeits. f. phys. Chem.* 138. *Abt. A.* 6. *pp.* 432–446, *Dec.*, 1928.

Le Blanc and Noyes found in 1890 that the addition of iodine to aqueous solutions of KI lowers the conductance because the little mobile ion I_3 is formed. On the other hand, Bruns and Thönnessen [see Abstracts 654 (1926) and 2186 (1927)] observed that iodine increased the conductance of aqueous solutions of CdI_2 and of alcoholic solutions of CdI_2, KI and HgI_2. As the ion I_3 would again be formed, this suggested an increased dissociation by the addition of iodine, which might be due to the breaking up of complex or of simple salts. The transference numbers of LiCl, LiBr and NaI in acetone and methyl alcohol and their mixtures were determined in order to study complex formation. It is found that NaI does not form complexes in acetone, alone and mixed with alcohol; LiBr forms complexes in acetone which the addition of alcohol destroys; LiCl is strongly complex in acetone, but the complexes are broken up by the addition of alcohol, especially in the early stages, as long as there are only 10 % of alcohol present. H. B.

1721. Influence of Iodine Addition on the Conductance of the Halides of Sodium, Lithium and Potassium in Mixtures of Alcohol and Acetone. F. Nies. *Zeits. f. phys. Chem.* 138. *Abt. A.* 6. *pp.* 447–458, *Dec.*, 1928.

Continuation of the research of Birkenstock [see preceding Abstract], but the method of measurement was that of Kohlrausch-Holborn, not that of Jahn and Hopfgartner. The results are: addition of iodine increases the conductance of NaI in mixtures of acetone and methyl alcohol; the effect diminishes as more alcohol is added. The conductance of LiBr in pure acetone is likewise increased. In solutions of KI and LiCl in pure alcohol the addition of iodine raises the conductance only when the solutions are concentrated; in dilute solutions the effect, especially of much iodine, is the opposite. The iodine breaks up complexes and simple molecules and unites, not only with the iodine of the iodides, but also with the other halogens forming complexes like $Cl\text{-}I_2$. The results are like those of Thönnessen in direct contradiction to the assumption of a complete dissociation of strong electrolytes. H. B.

1722. Anodic Behaviour of Palladium in Chloride Solutions. F. Müller. *Zeits. f. Elektrochem.* 34. *pp.* 744–752, *Nov.*, 1928.

In its electromotive behaviour in chloride-containing solutions of not too low hydrogen-ion concentrations, palladium differs completely from the other platinum metals. By passage of chlorine into the liquid or by anodic polarisation, the metal first dissolves at comparatively low potentials, to become suddenly passive when a certain critical current density is reached. As the concentration of added hydrochloric acid is increased, perfect passivity is attained at progressively lower potentials, and in the pure concentrated acid the metal remains quite active at high current densities. From base metals capable of passivity, such as iron and nickel, palladium differs in than it remains completely passive, like platinum in chloride-free solutions on anodic polarisation. Also in solutions containing bromide or iodide, a palladium anode passes into solution in the active form on polarisation. In the transition to the passive state, especially in iodide-containing solutions, characteristic pulsations occur, these being occasionally observed also in solutions containing chlorides. T. H. P.

1723. pH Measurement with Glass Electrode and Vacuum Tube Potentiometer. L. W. Elder, Jr., and W. H. Wright. *Nat. Acad. Sci., Proc.* 14. *pp.* 935–939, *Dec.*, 1928.

The potentiometer described is a valve consisting of filament, grid and plate as suggested for potentiometer titration by Goode [Abstract 1797 (1922)], because much more convenient for the analytical chemist than a quadrant electrometer. The glass electrodes are made of a glass of 72 % SiO_2, 8 % CaO and 20 % NaO; soft glass turns strongly positive in both acids and alkalis. The apparatus is used in connection with an Ag/AgCl cell as described by Morton [Abstract 1428 (1928)]. H. B.

1724. Passivity. Agnes M. Hasebrink. *Zeits. f. Elektrochem.* 34. *pp.* 819–829, *Dec.*, 1928.

Chromium, which has been made passive by different methods, is exposed to hydrogen, nitrogen and carbon dioxide, and the time required to change from the passive to the active condition is observed. The restoration of the metal, after treatment with these gases, to the passive condition on exposure to air is also determined. It is found that oxygen is the only agent which causes passivity, and that the varying facility with which the different samples of chromium become active or passive depends on their form and the nature of occluded gases, oxygen promoting and hydrogen retarding passivity. Iodine can activate but not passify. Measurements are made of potential changes produced by polishing chromium and nickel when in contact with different gases. The observed phenomena are best explained by the assumption that chromium always contains dissolved gases and particularly hydrogen. On scratching, a layer rich in hydrogen is exposed which gives a low potential, but on account of the small capacity the potential changes quickly. The oxygen theory of passivity is supported by the big rise of potential which occurs on leading oxygen over the chromium. With iron foil the influence of physical conditions on its active or passive properties during electrolysis is investigated. In considering the alternative theories which have been put forward, it is considered that passivity is undoubtedly related to the formation of an oxygen-containing layer, but that the hydrogen theory has some validity in that occluded hydrogen influences the assumption of the passive condition. It is considered that the ultimate cause of passivity resides in the atomic structure, since those elements exhibit passivity, which, on the basis of the Bohr atom model, possess inner groups of electrons with incomplete shells, and passivity is in some way related to the association of oxygen with these unsaturated layers whereby the metal becomes more noble. J. N. P.

1725. Current-Voltage Relation with Residual Current. W. J. Müller and K. Konopicky. *Zeits. f. Elektrochem.* 34. *pp.* 840–849, *Dec.*, 1928.

In measurements with a large number of metals it is found that when the oxygen is completely eliminated from the electrolyte by means of hydrogen, the residual current during kathodic polarisation with a stationary electrolyte only amounts to a few milli-amperes per cm.^{2}, while with an electolyte containing oxygen it is increased approximately ten times. With copper, lead, aluminium and nickel electrodes, the magnitude of the overvoltage values as determined by the position of the inflexion point of the curve is practically unaffected by the oxygen-content, but with platinum it is displaced by 0·14 volt, and with iron, by 0·1 volt in the nobler direction. The apparent single potentials of all the metals is displaced by the presence of oxygen towards noble values by an amount varying from 0·05 volt for copper to 0·25 volt for nickel. The explanation of this displacement as a passivity effect cannot be maintained, since the typical passivity phenomena are only observed at considerably higher current densities. The curve of hydrogen overvoltage follows the formula of Tafel as modified by Glasstone, according to which $E = a + b \log (D - C)$, where E is the potential, D, the current density, a and b are constants and C a small constant which corresponds to the residual current. The constants are evaluated for the different metals and this equation is found applicable to express the anodic solution and overvoltage relations. J. N. P.

1726. Periodic Phenomena at the Anode. W. J. Müller. *Zeits. f. Elektrochem.* 34. *pp.* 850–852, *Dec.*, 1928.

It is maintained that the passivity oscillation phenomena with nickel-chromium and iron anodes are to be explained by the metal transformation theory rather than by means of the oxide film theory of passivity which is advocated by Strauss and Hinnüber. The first potential rise with a nickel anode is attributed to the formation of a saturated layer of salt from the dissolving anode which eventually deposits a layer of solid salt near the anode surface. This is termed "coating passivity" and is sometimes referred to as anodic overvoltage. At higher current densities transformation of the metal to the passive condition results through the increased current density in the boundary layers of the metal resulting from this coating and is known as "chemical passivity." When passivity sets in, the concentration film begins to dissolve and activity of the metal is resumed at parts which become exposed. A local current then occurs between portions of the metal which have become passive and those parts of the surface which are insoluble through the presence of carbide or oxide grains. If the density of these local currents is sufficiently high, then parts also become passive, and when the value falls too low through increase in the areas exposed the passivity is no longer maintained and a prolonged local current is generated from these surfaces which have become passive, and this local kathodic current leads to an activation of the whole surface. The oscillations are thus due to the repetitions of these cycles [see Abstract 352 (1929)]. J. N. P.

1727. Periodic Phenomena at the Anode. J. Hinnüber. *Zeits. f. Elektrochem.* 34. *pp.* 852–853, *Dec.*, 1928.

In support of the oxide film theory of passivity it is replied to the views of Müller [see preceding Abstract] that the oscillating potentials accompanying the alternate active and passive condition of chromium anodes occur at lower passifying potentials than those leading to the state when chromium dissolves as the hexavalent ion. The rise of potential results from the formation of a film of oxygen which may be acquired initially from the gas dissolved in the solution, and leads to a progressive increase in potential. It is considered that the part played by surface inhomogeneities, such as the presence of particles of oxide and carbide in producing oscillating potentials, is that these act as local elements, the less noble dissolving with the formation of hydrogen, which annuls the effect of the oxygen layer. This view is supported by the observation that the surface of the passive metal may also be activated by contact with magnesium and, on removal, again become passive. The presence of the local element further accelerates the formation of the layer of concentrated metal salt, thus diminishing the attack by the acid, while the dissolved oxygen diffuses to the anode element and effects passivation. J. N. P.

1728. Metallic-Non-Metallic Electrode Pairs. B. Kamienski. *Zeits. f. phys. Chem.* 138. *Abt. A.* 5. *pp.* 345–348, *Dec.*, 1928.

For potentiometric estimations, where use is made of an electrode pair consisting of a metal and a non-metal, a carborundum electrode is prepared from a crystal of the pure material by coating with copper electrolytically on one side, by means of a current of 0·001 ampere, for 2 days, attaching a wire by soldering and cementing a holder consisting of a glass tube. The crystal is cleaned in nitric and chromic acids before use. Results are given of a number of titrations conducted with this electrode in conjunction with one of copper. The advantage of the carborundum electrode is that its potential is similar to that of the calomel electrode and is only slightly affected by the composition of the electrolyte. [See Abstract 345 (1929).] J. N. P.

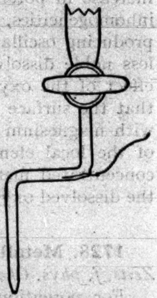
1729. Becquerel Electrocapillary Phenomenon. H. Freundlich and K. Söllner. *Zeits. f. phys. Chem.* 138. *Abt. A.* 5. *pp.* 349–356, *Dec.*, 1928.

According to the Becquerel phenomenon, when a metal salt solution is separated by a porous partition from a solution which forms a difficult soluble precipitate, a deposition of metal occurs on the metal-salt solution side of the partition. The effect is explained by means of a circular current. It is found that the mechanism of this reaction requires the precipitate to be more or less metallically conducting, and the e.m.f. of the concentration chain between the high concentration of the metal ions in the salt solution and the low concentration in the adjacent solution to be greater than the decomposition voltage which leads to separation of the metal. Measurements are made with copper sulphate in contact with sodium sulphide. Replacing this by selenide is found to make the phenomenon more pronounced. Examples described by Becquerel, consisting of silver nitrate or copper sulphate in contact with potassium hydroxide, which only operate in presence of an anodic depolariser, are accounted for by a lowering of the decomposition voltage through the depolariser. J. N. P.

1730. Electroosmose of Mixtures of Electrolytes. A. Boutaric and M. Doladilhe. *Comptes Rendus*, 187. *pp.* 1142–1144, *Dec.* 10, 1928.

Through a porous partition a solution of $CuSO_4$ is transported electrically towards the kathode, while a solution of $Cu(NO_3)_2$ is transported towards the anode. A study was made of the transport of solutions containing both these substances. Tables are given showing how the transport velocity for such mixtures varies with the concentration and the relative proportions of the two constituents. No simple law was found to represent the experimental results. A. W.

1731. Simple Reference Electrode for Potentiometric Titrations. H. H. Willard and A. W. Boldyreff. *Am. Chem. Soc., J.* 51. *pp.* 471–474, *Feb.*, 1929.



A reference electrode is constructed by sealing a piece of smooth platinum wire into the tip of a burette below the tap, as shown in the figure. By dipping the tip of the burette into the solution titrated, an electrical connection is established with the indicator electrode. Errors due to diffusion are found to be negligible and the constancy of the potential of the electrode is shown by titrations involving oxidation-reduction, neutralization and precipitation reactions. [See Abstract 1417 (1928).] J. N. P.

1732. Electrolysis of Cyanogen Halides. R. H. Clark and H. R. L. Streight. *Roy. Soc. Canada, Trans.* 22. *Sect.* 3. *pp.* 323–329, *May*, 1928.

In the electrolysis of the cyanogen halides, when employing silver electrodes and various solvents, the halide is in all cases found to travel to the anode, with the exception of iodine from iodocyanogen in pyridine, which goes to the kathode. Iodocyanogen behaves as an electromer, or $\overset{+}{I}\,.\,\overset{-}{CN} \rightleftarrows \overset{-}{I}\,.\,\overset{+}{CN}$, the iodine reacting negatively in electrolysis in most solvents, but entirely positively in pyridine solution. The concentration of the two electromers present in solution does not appear to be directly dependent upon the dielectric constant of the solvent, as is the case with ordinary tautomers. J. N. P.

1733. Electrochemical Reduction of Azo Dyes to their respective Amino Compounds. L. P. Hubbuch. *Univ. Pittsburgh, Bull.* 25. *pp.* 103–114, *Oct.* 25, 1928.

The reduction of six azo dyes to their corresponding amino compounds in sodium carbonate solution was studied. The reduction was carried out in a glass vessel using a mercury kathode. The anode was of platinum and separated by a porous pot. The most favourable conditions for the best yield of the reduction products as regards temperature, current density and concentration were determined. F. J. B.

1734. Electrochemical Preparation of Phenylhydrazine. R. E. McClure. *Univ. Pittsburgh, Bull.* 25. *pp.* 115–124, *Oct.* 25, 1928.

The electrochemical reduction of benzenediazonium compounds was investigated. Mercury was used as the kathode and platinum spirals formed the anode. Aniline was diazotised in the usual manner, and then reduced in the electrolytic cell devised for the purpose. The current efficiency was about 47·6 %. Details of actual reductions are given. F. J. B.

1735. Electrochemical Preparation of Hydrogen Peroxide. L. Löwenstein. *Zeits. f. Elektrochem.* 34. *pp.* 784–786, *Nov.*, 1928.

Aqueous solutions of hydrogen peroxide of about 2·7 % concentration have been prepared at kathodes of mercury or amalgam by direct union of the nascent hydrogen with oxygen which is passed at high pressures over the surface of the kathode. A current yield of 83 % has been obtained with 2 volts. In all technical methods at present in use for the electrolytic production of hydrogen peroxide, however, the compound is prepared from the anolyte from the electrolysis of sulphuric acid solutions. The cell is provided with a diaphragm and platinum anodes, and the anolyte product consisting of sulphuric, persulphuric and Caro's acid (H_2SO_5) is passed into a still when the following reaction occurs on heating:

$$H_2S_2O_8 + 2H_2O = 2H_2SO_4 + H_2O_2$$
$$H_2SO_5 + H_2O = H_2SO_4 + H_2O_2$$

The hydrogen peroxide is separated by distillation. Decomposition of these peracids also occurs, however, to give free oxygen, these reactions being accelerated by the presence of traces of catalysts such as platinum. The yields of hydrogen peroxide have been improved in one process by arranging the distillation so that the solution is passed in a thin layer over the heated walls of the still. In a further method an electrolyte of ammonium sulphate and sulphuric acid is used. The ammonium persulphate which is formed with a current yield of 80–90 % is converted to the potassium salt which is then heated in presence of sulphuric acid to give hydrogen peroxide and potassium bisulphate. By regeneration the operations are conducted as a cyclic process. J. N. P.

1736. Electrolysis through a Crystal Diaphragm. W. A. Plotnikow, M. Rabinowitsch and P. B. Zywotinski. *Zeits. f. phys. Chem.* 138. 3–4. *pp.* 260–267, *Nov.*, 1928.

Anode and kathode cells containing silver nitrate are connected by a diaphragm consisting of a bridge of solid silver iodide containing an admixture of silver chloride which increases the mechanical strength and diminishes the porosity. The bridge is mounted in a furnace, and its temperature raised to 160° C. On applying a p.d. of 160 volts to the respective cells, currents of about 30 milli-amperes are passed. Silver is deposited on the kathode, and nitric acid liberated in the anode cell in the amounts demanded by Faraday's law, while no trace of acid diffused into the kathode cell. This relation and the change of silver nitrate concentration in the electrolyte indicate that the current is conducted through the diaphragm by means of silver ions. In diaphragms which have been exposed to light or otherwise treated so as to deposit silver in the mass, it is observed that the silver particles migrate to the anode and separate these as a black deposit. On heating the deposit, luminescence occurs, and the metal changes to the bright form.

J. N. P.

1737. Electrolysis of Sodium Sulphide Solutions. W. R. Fetzer. *J. Phys. Chem.* 32. *pp.* 1787–1807, *Dec.*, 1928.

In the electrolysis of sodium sulphide solutions, when the current density is not too high, the only product of electrolysis is sodium polysulphide; with higher current density, sulphate and dithionate are formed, but no thiosulphate. When polysulphide is the only product of electrolysis, the electrochemical equivalent of sulphur is 16, whether the electrolyte be sodium monosulphide (Na_2S) or polysulphide. Solutions of acid sodium sulphide NaSH give, on electrolysis, polysulphide and hydrogen sulphide in the ratio of Na_2S_2 to $2H_2S$. The limiting current, or the current needed to liberate sulphur from a solution of mono- or polysulphide, increases at first with the proportion of polysulphide in the solution, passes through a maximum, and decreases towards zero. In the case of a solution of sodium monosulphide, the limiting current increases with increase in the rate of rotation of the anode, in quantitatively the same proportion as the limiting current for an acid solution of copper sulphate. With polysulphide solutions ($Na_2S \,.\, S_{1\cdot 01}$ and $Na_2S \,.\, S_{1\cdot 82}$) the limiting current remains unchanged when the rate of rotation is increased from 220 to 700 r.p.m., but is doubled with the monosulphide solution. Increasing the temperature increases the limiting current. In the case of a monosulphide solution, the limiting current is proportional to the concentration; the same is true for polysulphide solutions when the ratio of sulphur to sodium does not exceed that given by the formula Na_2S_3. When a polysulphide solution with high sulphur ratio ($Na_2S \,.\, S_{2\cdot 7}$, $Na_2S \,.\, S_{2\cdot 9}$) is diluted by adding water, the limiting current observed depends upon the time that has elapsed after the water has been added; it is highest at first and falls to a steady value. When a polysulphide solution is heated and then cooled, its limiting current immediately after cooling (but after the solution has regained its original colour) is low, and gradually increases with time, reaching a steady value only after many hours. When a sulphide solution is cooled after heating with excess of sulphur, much of the sulphur separates; and the solution so obtained retains less sulphur than one that has been shaken with sulphur for a long time at room-temperature. J. N. P.

1738. Theory of Processes at Unpolarisable Electrodes. M. Volmer. *Zeits. f. phys. Chem.* 139. *pp.* 597–604, *Dec.*, 1928.

By means of a modified oscillographic method as used by le Blanc, kathodic polarisation measurements are made over short time intervals during the deposition of zinc on different kathodes. With a 1 % liquid zinc amalgam no polarisation is observed over a period of 1/80 sec. On a zinc surface consisting of small crystallites obtained by subliming the metal on to a glass surface in a high vacuum or by electrodeposition from a zincate solution on a silver foil the polarisation is scarcely perceptible. With electrodes consisting of zinc with a large well-developed crystal surface a marked polarisation, both anodic and kathodic, is given. In place of the ionic dehydration theory of le Blanc the primary feature in the electrodeposition of a metal is considered as a crystallisation phenomenon which is influenced by the crystal structure of the base metal, and polarisation is regarded as arising from supersaturation due to the retardation imposed in forming the crystal lattice. The metal is regarded as being first deposited in the form of an adsorbed layer of metal atoms, the nature of which is discussed by considering the influence on the thermionic emission from metals of thorium and cerium which are adsorbed as an atomic layer corresponding to the electrochemical double layer. The saturation current, and consequently the electronic density, when in equilibrium is increased on account of the more marked ionic character of the adsorbed metals. The entering of an electrolytic deposit into the space lattice is preceded by the formation of a similar layer of adsorbed quasi-ions, and dehydration only occurs as these enter the crystal lattice. J. N. P.